5.2 Preliminary Design of Irrigation Facilities

(1) Basic concept

The following basic concepts are applied for the preliminary design of irrigation facilities in line with the development strategy:

- Irrigation water impounded by the Embung is supplied firstly to the existing cropped field, irrigated or rainfed, in the beneficiary area;
- Irrigation area is defined taking into consideration the available cropped field and the effective storage capacity of Embung;
- Irrigation canals from the outlet of Embung to the head of existing cropped field is constructed in the form of open channel as much as possible from the economic viewpoint;
- Irrigation system in the existing cropped field is be developed by farmers themselves, as the irrigation system commands around 50 ha only. No consideration is taken into in terms of new land reclamation;
- Proper design of canal alignment for gravity irrigation is considered paying special attention to avoid adverse effect on environment; and,
- Drainage improvement is not required for the existing cropped field since the beneficiary area is situated on well drained land.

(2) Irrigation plan

The outlet works of the Embung are planned to be used for dual purposes of supplying irrigated and domestic water. The water taken from the reservoir is led to the valve house through the cast iron pipe provided in the right abutment of the dam. The water is then diverted to irrigation and domestic water supply channel at the valve house with check valve and flow meter.

Irrigation water diverted at the valve house is discharged to the irrigation inlet box to make the open flow from the pipe pressure flow. The irrigation inlet box is constructed at the upstream portion of the existing canal next to the toe of downstream slope of the dam embankment. From the irrigation inlet box, irrigation water flows down in the existing canal. Irrigation water is delivered to the beneficiary paddy field by using the existing irrigation canals.

General layout is shown in Figure 5.1 including the layout of irrigation canals and pipe lines for domestic water supply.

(3) Design discharge and initial water level

Design discharge for canal and related structures are decided based on the irrigation water requirement and proposed cropping pattern. Peak semi-monthly base diversion requirement for the unit irrigation area of 1.0 ha is defined as design discharge after multiplying the irrigation area. Peak diversion requirement occurs in the second half month of May for the dry season paddy crop and its design discharge is estimated at 500 lit/sec for the net irrigation area of 248 ha. This design discharge is enough to flow design discharge for dry season Palawija crops of net area of 248 ha at peak time.

Initial water level at the irrigation inlet box is decided taking into consideration the surface and bottom elevations of the existing irrigation canal next to the inlet box. As a result, the initial water level is El. 21.0 m at the irrigation inlet box.

(4) Irrigation facilities

Design of irrigation facility is made based on the 1/5,000 topographic map prepared under the Study.

Canal related structure required is irrigation inlet box. Required irrigation facilities are summarized below.

Irrigation Facilities Requirement

Facilities	Quantities
- Valve house (included the facilities for Embung)	1 No.
- Irrigation inlet box	1 No.
- Masonry canal to be rehabilitated	11.7 km

5.3 Preliminary Design of Water Distribution Facilities

The main components of water distribution facilities to inhabitants in the beneficiary area are pipe lines, division boxes with filter system for inhabitants and related structures of pipelines.

Preliminary design works for each water distribution system are carried out based on the following basic concepts.

- Distribution facilities to the beneficiary area are laid out taking into consideration the effective storage capacity of Embung, topographic condition of the Project area and village boundary;
- Water demand for inhabitants is fully reflected in the preliminary design of pipeline and the layout of division boxes in the beneficiary areas;
- Pipeline system with pressure flow is taken up for water distribution network from the Embung to its beneficiary area. Pipes are laid along the existing roads as much as possible from the viewpoint of easy O&M works of pipeline system. Pipes are laid under the ground with a depth of 50 cm;
- Division boxes for inhabitants are arranged based on the water demand in the beneficiary area, water conveyance distance between a division box and its users' houses and topographic condition of a site for constructing a division box. The designed capacity of division box for inhabitants is 6,000 lit to cover daily water demand of 100 persons.
- Related structures of pipelines such as check valves, air valves and blowoffs are set taking into account the topographic condition along and layout of the pipeline system.
- High Density PVC pipes are used for the water supply in due consideration of the safety against unexpected high pressure to the pipes, the steep and undulating topographic condition and the easiness to get the materials in Indonesia.

The design discharge of pipeline is decided on the basis of the unit water demand of inhabitants as well as projected population of inhabitants for the beneficiary area.

Main features of the pipeline system are summarized below.

Main Features of the Pipeline System

Facilities	Quantities
Pipeline (Dia. 150 mm)	7.5 km
Check valve	4 Nos.
Air valve	4 Nos.
Blowoff	3 Nos.
Division box for domestic water	38 Nos.

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding.

The construction plan is based on the mode of construction and the target schedule of construction works as well as local conditions such as availability of construction labor, material and equipment as well as weather and topographic conditions of the construction site.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter and rock embankment works and 300 days per year for concreting works in view of the daily rainfall distribution in the Project area. For each working day, 8-hour shift is applied.

(2) Construction schedule

The overall construction schedule is determined as shown in Figure 6.1 taking into account the necessary time of detailed design, bidding procedure including the time of tender evaluation and award of the contract. The major points of construction schedule are described below.

1) Mobilization and preparation works

Immediately after received the "Notice to Proceed", the contractor would commence the mobilization of construction equipment and key staff to the Project site from the beginning of November in the first year. Following this, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of all the structures would be commenced by the contractor at the Project site. Construction of temporary access roads such as access to the borrow area and access to major structural sites shall be stated by using equipment available at the Project site. The excavation works for the river diversion channel and the main dam would be commenced at the beginning of March in the second year.

3) Embankment works and excavation of spillway

After diversion of the river water into the diversion channel and completion of foundation treatment works, the embankment works for the main dam will be commenced and continued until the wet season in the second year starts. Excavation works for the spillway will also be concentrated and completed before October in the second year.

4) Concrete works of spillway and water supply system

Concrete work of the spillway will be commenced in March and completed before October in the third year. Excavation and concrete works of the water supply system will be done in the wet season between the second and third year.

5) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at beginning of October in the third year after completion of the main dam embankment and sillway construction. Considering the rainfall in November and December in the third year, the Pelangan reservoir would be full reservoir water condition, accordingly the water can be supplied from the reservoir to the water users from January in the fourth year.

6) Water distribution system

Construction works for the water distribution system will be executed in parallel with the construction works of the Embung by using mainly manpower because of the work quantities for them are not so much. These works shall be completed by the end of December before supplying the reservoir water to the beneficiary area.

6.2 Construction Plan of Embung

(1) Preparatory works

The preparatory works consist of preparation of temporary buildings, construction plant and repair shop, arrangement power and water supply systems as well as communication system, construction of access and haul roads, and so on. All of these works will be conducted from November in the first year to February in the second year.

1) Temporary buildings and yards

The temporary buildings required for the construction would include office, quarters, workshop, warehouse and storage yards. These temporary buildings will be built by the contractor.

2) Water and power supply

The water required for the construction works and the daily use in the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the contractor's diesel generators.

(2) River diversion works

The river flow will be released through the river diversion channel for one year from March in the second year to the end of April, in the third year, and therefore the river diversion channel would be provided along the right bank of the Pelangan river.

(3) Main dam works

Following the foundation excavation and grouting works and completion of the river diversion channel, the embankment works for the main dam will be commenced at the beginning of July in the second year. Considering a total embankment volume of 622,000 m^3 and the dry season period of 10 months until the end of September in the third year, the daily embankment volume is to be 2,400 m^3 which is quarried from the reservoir area.

(4) Spillway construction

Excavation of the spillway will be scheduled to be performed for about five months from March to September in the second year. Most of the excavated materials may be used for the main dam embankment so that the excavated material will be stocked on the designated area.

After completion of the spillway excavation, concrete works of weir and chuteway will be commenced. Before starting the reservoir water impounding at the beginning of October in the third year, major concrete works of the spillway shall be completed in order to release the flood discharge in the following wet season.

(5) Water supply system

The inlet structure of water supply system is constructed above the sediment load disposition level of El. 25.8 m in the reservoir area. Connecting with the inlet structure, steel pipe with a diameter of 500 mm is installed up to the downstream end of the main dam. Construction of the water supply pipe should be completed before commencement of the main dam embankment at the beginning of May in the third year.

The valve house of the water supply system will be constructed before the reservoir water reaches to F.S.L of El. 41.0 m, around the end of December in the third year.

6.3 Construction Plan of Irrigation Facilities and Water Distribution Facilities

Since the irrigation and water distribution facilities to be constructed are rather small in work quantities and scattering in the beneficiary area in comparison with the construction Embung works, almost all the works except earth works for irrigation canal will be basically executed by man power. Earth works for the irrigation canal such as clearing, stripping, excavation and embankment works will be executed by using heavy construction equipment including bulldozer, excavator, compactor, and so on. All of these works will be executed in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Responsible organization for Project implementation

In the course of Project implementation, DPUP of NTB, after getting approval from DGWRD, will direct the PKSA Lombok Project Office to commence undertaking of detailed investigation and design works of the Pelangan Embung. These works will be done by the Survey and Investigation Section as well as the Technical Design Section of the said Project Office. Based on the cost estimate, DPUP of NTB will disburse budget for land acquisition and construction of Embung and related facilities to the Project Office using development budget allocated from the Central Government. Before starting construction work, land acquisition work will be carried out by the Land Acquisition Section of the Project Office. Supervision of construction works, being entrusted to a contractor through tendering, will be the responsibility of the Construction and Implementation Section of the Project Office.

(2) Technical resources input

In due consideration of the current availability of engineers and technical staff as well as the annual development target in the PKSA Lombok Project Office, it is necessary to utilize technical resources outside the Project Office to the maximum extent for enabling the Project Office to realize its target. In this connection, undertaking of detailed investigation and design works for the Pelangan Embung need to be entrusted to consultants aiming to

secure smooth implementation of the Project in accordance with the implementation program made by the Project Office.

(3) Organization for O&M

After completing all of the project works for Pelangan Embung, DPUP of NTB will submit its completion report to the Minister for Public Works through DGWRD and therefrom the notice of Project completion will be transferred to the Minister for Home Affairs. After receiving the Minister's direction, the Governor of NTB Province will order DPUP of NTB to take a necessary action for O&M of the said Project facilities. Following this, DPUP of NTB will direct its Provincial O&M Project Office to arrange O&M works and disburse the Provincial Government's budget to DPUP Kabupaten Lombok Barat Office.

(4) Water User's Association (P3A)

In the Project area, the existing P3A has been active since 1993. It is therefore necessitated to make the new beneficiary farmers become members of this P3A and to train them by using training materials and modules prepared by the Water User Training Program under DGWRD.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for developing the Pelangan Embung is estimated on the basis of assumptions as follows :

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 20% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTB as of October 1994 and the data collected from the on-going projects in NTT and NTB. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of PRWS's staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to the recent other project costs in NTT and NTB;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow areas, and land of pipe line, irrigation canal and permanent structures and is estimated at 0.5 % of the direct construction cost taking into consideration the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction works will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of direct construction cost, administration cost, engineering service cost, physical contingency,

contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Pelangan Embung is estimated at Rp. 23,648 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works is shown in Table 7.2 together with work quantities of the main work items and their unit prices.

The total Project cost for constructing the Pelangan Embung is summarized below.

Summary of Project Cost for Pelangan Embung

Unit : Rp. Million

Item		Project cost
I.	Direct construction cost	12,982
1.1	Preparatory works	618
1.2	Embung construction	11,627
1.3	Irrigation facilities	114
1.4	Domestic water supply	623
1.5	Operation & maintenance road	0
II.	Administration cost	649
III.	Engineering services	1,947
IV.	Physical contingencies	2,337
V.	Contract tax	1,727
VI.	Land acquisition	65
VII.	Price contingency	3,941
	Grand Total	23,648

7.3 Operation and Management Cost

The O&M costs consist of salaries of O&M staff, cost for maintaining the project facilities, material and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are estimated at Rp. 118.2 million, which is equivalent to 0.5 % of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

The benefit of domestic water supply to beneficiary inhabitants in Sekotong Barat Village could be indicated as the value of water and the investment amount to each beneficiary inhabitant. If the total amount of direct construction cost is defined as the total amount of investment for the construction of Pelangan Embung, this investment amount could be allocated to the investment in domestic water supply according to the proportion of annual domestic water demand against the total annual water demand. Then, the value of water can be estimated by dividing the sum of allocated amount of direct construction cost of Embung and the whole amount of domestic water supply system by the annual domestic water demand, while the investment amount to each beneficiary inhabitant can be given by dividing the said sum by the total number of domestic water users.

The direct construction cost is broken down into the cost for Embung construction and preparatory works of Rp. 12,245 million, irrigation facilities of Rp. 114 million and domestic water supply system of Rp. 623 million. The total number of beneficiary inhabitants is 4,800 persons. The annual water demand is 0.1765 MCM for domestic use and 7.4 MCM for irrigation use, totaling 7,577 MCM. The direct construction cost is allocated as shown below.

Allocation of Direct Construction Cost

Item	Unit	Total demand	Domestic water	Livestock water	Irrigation water
Annual water demand	'000 m^3	7,577	177	0	7,400
Direct construction cost	Million Rp.	12,982	909	0	12,073

Thus, the benefit of domestic water supply is indicted by the value of water of Rp. 5,136/m^3 and also the investment amount to the respective beneficiary inhabitants of Rp. 189,375/person.

8.2 Economic Consideration

(1) Economic cost

The financial costs are to be converted into the economic costs by applying the economic conversion factor (ECF) established by DGWRD in 1985. The ECFs applied are: 0.71 for preparatory works and all civil works including Embung, irrigation facilities, domestic water supply system and road networks; 0.75 for unskilled on-farm labor and farm labor; 0.80 for land clearing, on-farm development and operation and maintenance cost; and tertiary irrigation system development, 0.90 for design and survey works and administration; and 1.00 for O&M equipment and replacement cost.

When the financial cost is converted to the economic cost, the contract tax, land acquisition cost and price contingency are fully excepted. In this Study, only the purchasing cost of consumables and goods appropriated in the administration cost is to be converted to the economic administration cost, as the normal payment to civil servants is principally appropriated in the operation budget of the Government. As the construction cost of dam and engineering cost estimated include some allowance to cover additional cost for expatriates, 50% of the engineering cost is to be converted to the economic cost in order to make the estimated cost equal to the level of local cost.

The economic cost converted and its annual disbursement schedule are shown in Table 8.1.

(2) Economic benefit

The irrigation benefits of the Project are principally derived from increased crop production attributable to stable irrigation water supply, full utilization of available farm land resources and optimum farm input supply. Table 8.2 gives financial and economic prices of farm inputs and outputs estimated for major islands. Based on the proposed quantity of farm inputs, anticipated crop yield and economic farm gate prices, the economic crop budget is estimated as shown in Table 8.3.

The annual net incremental benefit is thus estimated to be Rp. 789.9 million. This increment benefit will accure from the first year when irrigation water can be released from the Pelangan Embung. Taking the present agricultural situation and farmers capability into account, it is assumed that five years are needed as the build-up period to attain the anticipated crop yield level. In the proposed reservoir area, rainfed paddy field of 2 ha and dry upland growing maize of 8 ha will be under the reservoir water after completion of the proposed Pelangan Embung, the total amount of production foregone is estimated to be around Rp. 2 million.

(3) Economic evaluation

The economic internal rate of return (EIRR) is examine as shown in Table 8.4 on costs and benefits as at August 1994. The result of economic analysis shows that EIRR is 3.6%, but the proposed Pelangan Embung Project would still have a significant positive impact on the development of the economically depressed area within Lombok island as it can be expected to increase paddy production by 1,714 tons or 3.3 times and to enhance cash income source by introducing irrigated cultivation of red onion with very high demand in local markets of urban areas. Furthermore, the pressing BHN in Desa Sekotong Barat can be met by constant supply of clean domestic water to 4,800 inhabitants even in the dry season.

(4) Farm budget analysis

With the implementation of Pelangan Embung Project, the net on-farm income of farmers holding a unit farm size of 1.0 ha can be expected to increase by Rp. 4,272,900/year from Rp. 499,800/year under the "Without Project" condition with the cropping intensity of 111% to Rp. 4,772,700/year under the "With Project" condition with the cropping intensity of 300% as shown in Table 8.5 and below. Such improvement of farm budget would give much incentive for farmers to make further investment in improvement of their living standard and also could increase their payment capacity enabling beneficiary farmers to pay irrigation water charge to some extent.

Farm Budget for Unit Farm Size of 1 Ha

Crop	Watering Condition	Without Project		With Project	
		Crop Intensity (%)	Income (Rp.)	Crop Intensity (%)	Income (Rp.)
Paddy	Wet/Raided	34.7	214,099	-	-
	Wet/Irrigated	52.4	235,669	100.0	1,009,875
	Dry/Irrigated	-	-	100.0	1,019,875
Maize	Wet/Rainfed	1.2	2,615	-	-
Mungbean	Dry/Rainfed	10.5	47,415	-	-
	Dry/Irrigated	-	-	50.0	537,210
Red onion	Dry/Irrigated	-	-	50.0	2,205750
Fallow		11.7	0	-	-
Total		110.5	499,798	300.0	4,772,710

8.3 Environmental Impact Assessment

Environmental impact assessment for the Project is carried out in consideration of the main development objectives of the Project

(1) Environmental features of the Project area

The principal features of human and physical environment in the Pelangan Project area are summarized as below.

Environmental Features in the Pelangan Project Area

Item	Description
1. Human Environment	
Social intention	Insufficiency of reliable water sources and facilities for irrigation water and domestic use
Human use	Use of well water (shortage in the dry season)
Economic activities	Cultivation of irrigated paddy and Palawija, and livestock farming
Health and sanitation	Prevalence of waterborne intestinal diseases
2. Physical environment	
Geology/land	Volcanic rocks, sedimentary rock of Tertiary
Surface/ground water	Surface water from catchment area of 32 km^2 is observed
Endemic fauna and flora	None
3. Others	There exists a Hindu altar in the proposed reservoir area

(2) Environmental impact assessment

The following three points can be considered as potential negative impacts by Embung development in this Project area:

- The first point is to accelerate soil erosion caused by cutting of trees in the catchment area and further increase in sedimentation inflow into the reservoir. Trees in both the reservoir and catchment areas have been utilized by the inhabitants for their economic activities producing water-carriers and other baskets, firewood, timber, alcoholic beverage, sap of sugar, and so on. Decrease of vegetation caused by logging has severely incurred a deterioration of water conservation and acceleration of soil erosion in the catchment area. Furthermore, limitation of the logging area by the Embung construction accelerate logging activities in the catchment area. This fact results in not only a further deterioration of water conservation and acceleration of soil erosion, but facilitates excess sedimentation of which the life span of the reservoir is shortened;

- The second point is an impact caused by shifting of social and economic basis which have long constituted in the reservoir area. At present, there are around 60 families and farmland of 10 ha in the reservoir area. In Indonesia, an expropriation of land regarding development project is usually carried out by means of recommending an alternative land. According to this custom, the inhabitants in the reservoir area involuntarily evacuate and are made to settle in a recommended land, where social and economic circumstances are unlike as compared with the current status. The changes of aspect regarding social and economic basis result in occurrence of resistance or apprehension against new customs and activities among the settled inhabitants, and further of discord between them and inhabitants who have already lived in; and

- The third point is a moral impact among the believers of Hindu caused by the submergence of Hindu altar. In the reservoir area, the Hindu altar which is 2.5 m

in height, 0.5 m in width and 0.8 m in depth and is surrounded by the paling of 7 m square, locates at the right bank of just upstream from the Embung. This altar was constructed in order to pray the safety and success of construction of head works which locates at the just point of Embung and had been broken and damaged by the flood many times. Since this altar was set up by the investment of the contractor for head work in cooperation with Hindu believer in 1985, this head work was completed without any damages and the altar has been revered by them. This altar, however, will be submerged by the construction of Embung. If the altar is substantially forfeited, Hindu believer must have a fear against occurrence of calamities.

Countermeasures for these points will be taken into consideration as follows:

- The countermeasure to eliminate this environmental impact is to establish an effective watershed management rule and conduct a campaign for participation of inhabitants in forest conservation activities. Additional incentives are required to encourage inhabitants to diversify their economic activities on on-forest basis.

- The mitigatory measure to alleviate these potential impacts is to settle, in principle, in the beneficiary area, to provide equivalent or better social basis as possible and to train resettlers in order to follow shifted economic activities. In addition, meeting and hearing regarding project implementation should be held with participation of both inhabitants so that it is possible to reduce such discords or other troubles as mentioned above; and,

- The countermeasure to reduce this impact is to shift to an appropriate place in consideration of historical background of the altar.

(3) Primary information of environmental assessment

To support environmental analysis presentation for this Project implementation on the Indonesian rule, primary information on environmental assessment is compiled in the Attachment to the Volume 4.

8.4 Contribution to Women in Development

With provision of permanent water source facilities, women and children of 982 families can be quite free from their daily hard job to carry their domestic water at the average distance of 150 m. As a result, women will be able to utilize the saved time for improving their activities in relation to not only agriculture and livestock but also small business. Since housewives in the Project area manage their family budgets, increasing farmer's income would encourage women in investing surplus in improvement and diversification of their economic activities.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

On the basis of categorization of 157 candidate schemes for the Study, the Pelangan Embung scheme is selected representing a typical sample scheme of which potential beneficiary area has its irrigation water intake on the source river of the proposed Embung, good farming system with the maximum extent of designed irrigation area and inhabitants' demand for further use of irrigation and domestic water. The proposed Pelangan Embung site has physically irrigable land resources of 284 ha in net and the annual discharge of 23.6 MCM from its catchment area of 46.0 km ^{2}. A total of 4,800 inhabitants projected for the year of 2008 needs additional water source facilities to solve their water shortage problem during the dry season.

As there is no limitation in the topographic condition and the availability of water resources, the future water demand for irrigation and domestic use in the beneficiary area is the determining factor in the optimization of development scale. To cover the physically irrigable area by gravity method and the domestic water demand of inhabitants to the maximum extent, the dam height of Pelangan Embung is thus set to be 29.5 m with the total and effective storage capacities of 5.70 and 5.04 MCM, respectively. Under such condition, it can be expected to practice double cropping of irrigated paddy followed by irrigated cropping of high-valued Palawija crops and to meet increasing domestic water demand of 4,800 inhabitants in the beneficiary area.

The structural components are main dam and spillway as well as irrigation and domestic water distribution systems. The zoned embankment dam is constructed with the crest length of 360 m, embankment volume of 622,000 m^3 and side-channel typed spillway having design flood discharge of 522 m^3/sec and overflow weir width of 73 m. The required investment cost amounts to Rp. 23.6 billion of which direct construction cost is estimated to be 13.0 billion.

The results of feasibility study reveal that construction of the candidate Embung at the proposed site is technically sound but economically marginal because of a rather limited availability of irrigable land resources. The increasing domestic water demand of 4,800 inhabitants in the Project area could be fully met by creating a new clean water source through construction of the proposed Pelangan Embung. Therefore, such type of Embung is worth implementing from the socio-economic viewpoints.

9.2 Recommendations

In the intensification of the farming system to the target level with the cropping intensity of 300%, it is recommended to improve farming practices and on-farm irrigation water management skills of the beneficiary farmers through strengthening of agricultural extension services and water management training programs.

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Pelangan Embung Development Project

Tables

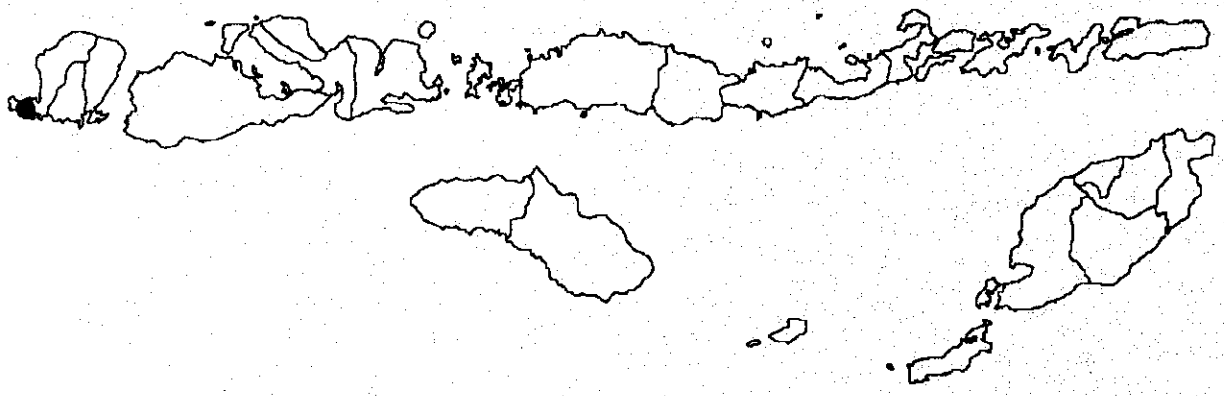


Table 1.1 Rainfall Record in Sekotong

SEKOTONG (SOURCE CRIPPEN + DPU) L39

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1950	447	156	88	79	19	193	21	84	12	197	258	236	1800
1951	220	425	79	75	0	101	0	0					
1952	184	165	165		43	0	0	0	0	31	218	135	
1953	180	149	168	66	82	0	16	0	0	0			
1954	146	48	100	295	96	3	0	75	0	64	111	288	1226
1955	228	307	75	164	164	223	206	33	9	124	150	245	1928
1956	300	154	63	55	120	121	81	66	23	51	111	244	1389
1957	296	382	224	0	71	2	84	7	0	0	74	177	1317
1958	76	259	103	39	34	59	43	16	0	33	27	339	1028
1959	234	146	229	61	159	235	0	0	0	21	150	339	1574
1960	459	365	21	93	129	0	73	0	23	3	115	163	1444
1961	249	259	301	144	14	0	0	0	0	23	211	60	1261
1962	263	197	70	70	130	0	0	54	0	61	15	293	1153
1963	649	56	95	68	0	0	0	0	19	49	20	164	1120
1964	134	208	241	66	30	26	0	0	57	192	231	218	1403
1965	319	109	131	21	0	0	0	0	0	8	105	143	836
1966	84	338	125	82	0	0	0	0	13	0	160	207	1009
1967	388	164	146	83	0	0	0	0	0	12	81	288	1162
1968	473	311	110	110	138	115	105	48	6	63	97	339	1915
1969	90	105	103	172	0	12	0	0	2	40	81	12	617
1970	133	187	32	59	140	36	0	0	35	20	102	103	847
1971	167	154	117	45	34	0	0	0	53	67	114	57	808
1972	113	158	489	38	100	0	0	0	0	0	74	209	1181
1973	140	210	140	139	205	33	10	0	100	122	82	196	1377
1974	254	263	380	0	41	0	6	69	67	94	233	274	1681
1975	181	456	355	122	264	0	0	0	35	276	254	310	2253
1976	232	36	89	0	0	30	0	0	0	77	87	49	600
1977	437	567	232	21	0	36	0	0	0	0	39	111	1443
1978	306	192	152	149	173	271	148	101	144	66	214	323	2239
1979	198	190	242	149	189	70	0	0	106	69	128	142	1483
1980	381	277	171	189	24	0	0	0	5	8	300	321	1676
1981	258	239	159	178	118	40	138	68	52	56	334	199	1839
1982	245	135	106	90	0	0	0	0	0	6	20	225	827
1983	75	145	40	45	200	1	0	0	0	178	192	160	1036
1984	342	174	248	101	86	0	0	0	147	94	122	199	1513
1985	95	425	381	147	34	9	0	0	0	9	200	134	1434
Max.	649	567	489	295	264	271	206	101	147	276	334	339	2253
Mean	249	226	166	92	79	45	26	17	26	60	139	203	1346
Min.	75	36	21	0	0	0	0	0	0	0	15	12	600

Sum of monthly means = 1330

Table 1.2 Climate in Rembiga

Station: Rembiga
Island : Lombok
Kabupaten :

Latitude : 08 34 S
Longitude : 116 04 E
Elevation : 3 m

Description	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average	Year
Average daily maximum temperature	C	30.4	30.3	30.4	31.3	31.2	30.4	30.0	30.7	30.9	31.5	31.1	30.8	30.8	1971 - 1979
Average daily minimum temperature	C	23.3	23.2	22.6	21.6	21.3	20.5	19.9	20.1	21.3	22.1	22.9	23.1	21.8	1971 - 1979
Mean daily temperature	C	26.9	26.8	26.5	26.5	26.3	25.5	25.0	25.4	26.1	26.8	27.0	27.0	26.3	1971 - 1979
Mean daily relative humidity	%	80.0	82.0	83.0	81.0	81.0	79.0	75.0	77.0	77.0	78.0	81.0	82.0	80.0	1971 - 1979
Mean daily wind run over 24 hours	km/day	289.0	236.0	223.0	178.0	183.0	214.0	227.0	245.0	240.0	205.0	191.0	191.0	219.0	1971 - 1979
Wind speed at time of observation	m/s	3.4	2.7	2.6	2.1	2.1	2.5	2.6	2.8	2.8	2.4	2.2	2.2	2.5	1971 - 1979
Mean daily observed bright sunshine	hr/month	158.0	155.0	174.0	201.0	208.0	204.0	220.0	217.0	201.0	198.0	201.0	174.0	2,311.0	1971 - 1979
Mean daily observed bright sunshine	hr/day	5.1	5.5	5.6	6.7	6.7	6.8	7.1	7.0	6.7	6.4	6.7	5.6	6.3	1971 - 1979
Mean daily maximum possible sunshine	hr/day	12.5	12.4	12.2	12.0	11.8	11.7	11.8	11.9	12.0	12.2	12.5	12.6	12.1	1971 - 1979
Mean Solar Radiation	mm/day	16.2	16.2	15.8	14.5	13.2	12.5	12.8	13.8	15.0	16.0	16.1	16.3	14.9	1971 - 1979

Source : Repprot (Nusatenggara, Maluku, Timor Timur) Annex 3

Table 1.3 Typical Soil Profile in the Pelangan Project Area

Profile No.:	8
Soil Classification:	Oxyaquic Ustropepts
Physiography:	Alluvial fan
Topography:	Flat (0 - 2 %)
Land Use/Vegetation:	Irrigated paddy field
Parent material:	Alluvium
Drainage:	Well
Groundwater Table:	3 *m*
Permeability:	Slightly slow (1.5 cm/hr)
Land Morphology:	Cracking 205 cm width, 25 cm depth

Horizon	Depth (cm)	*Description*
Ap	0 - 25	Light yellowish brown (10YR 6/4, dry), dark yellowish brown (10YR 4/2, moist); clay loam; moderate, sunangular, blocky, fine-medium structure; sticky, plastic, very firm, very hard consistency; fine root; clear, smooth horizon boundary
AB	25 - 70	Very dark grayish brown (10YR 3/2, dry and moist); clay loam; few, coarse material; few-common, fine distint mottling; strong, angular blocky structure; sticky, plastic, very firm, very hard consistency; few, fine root; clear, smooth horizon boundary
Bw1	70 - 100	Yellowish brown (10YR 5/4, dry), brown (10YR 5/3, moist); sandy clay loam; many coarse material; strong, subangular, blocky, medium structure; sticky, plastic, firm, hard consistency; clear, smooth horizon boundary
Bw2	100 - 110+	Yellowish brown (10YR 5/4, dry), brown (10YR 5/3, moist); sandy clay loam; many coarse material; strong, subangular, blocky, medium structure; sticky, plastic, firm, hard consistency

Source: Soil survey carried out by the local consultant under supervision of the JICA Study Team

Table 1.4 Results of Soil Laboratory Test in the Pelangan Project Area

Soil Pit	Layer	Texture			Permeability	pH	pH	Organic	Total N	Ava. P	CEC	Ex. Na	Ex. Ca	Ex. K	Ex. Mg	Base	EC
		Sand (%)	Silt (%)	Clay (%)	(cm/hr)	(H2O)	(KCl)	matter	(%)	(ppm)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	Saturation (%)	(mS/cm)
3	Ap	46.4	35.3	18.3	10.4	6.4	5.7	2.17	0.05	2.33	17.87	1.56	6.69	2.43	2.03	71	1.28
	Bw1	48.6	39.0	12.3	15.4	6.8	5.7	0.07	0.04	2.62	7.20	1.04	3.73	1.32	0.77	95	0.12
	Bw2	38.0	38.6	23.4		6.4	5.5	0.66	0.04	4.06	26.87	2.07	5.21	1.98	2.59	44	0.44
8	Ap	38.4	29.8	31.8	1.5	6.5	5.7	1.50	0.06	3.08	20.80	0.75	9.79	1.28	2.64	70	0.20
	AB	46.4	28.6	31.0	1.0	6.9	5.5	0.68	0.04	3.00	20.07	1.06	9.97	1.26	2.56	74	0.18
	Bw1	67.3	25.1	27.4		7.2	5.8	0.22	0.03	2.91	20.53	0.58	10.14	0.89	2.44	68	0.08
17	Ap	13.3	51.1	35.6	3.5	7.1	5.8	2.35	0.07	5.08	29.29	0.69	8.16	1.77	3.61	49	0.34
	C	60.7	16.3	19.4	6.1	7.0	5.8	0.86	0.03	6.32	19.48	1.21	8.19	1.17	2.03	65	0.20
	2A	42.4	22.6	35.0		6.8	5.4	0.44	0.03	7.02	37.57	1.72	7.90	0.87	3.72	38	0.16

Source: Soil survey carried out by the local contractor under supervision of the JICA Team

Table 1.5 Soil Classification in the Pelangan Project Area

Land Unit	Description	Physiography	Topography	Potential Suitability			Area	
				Paddy	Soybean	Maize	(ha)	(%)
I	Oxyaquic Ustifluvents deep; fine loam-coarse loamy; neutral; high CEC; moderate permeability; well drainage	Alluvial fan	Flat-undulating (4-5%)	S1/S3	S1	S1	75	13%
II	Oxyaquic Ustropepts deep; fine clay-coase loamy; neutral; moderate-high CEC; slightly slow-rapid permeability; well drainage	Alluvial fan	Flat-rolling (0-10%)	S1/S3	S1	S1	159	27%
III	Typic Haplustalfs deep; fine silty; neutral; moderate CEC; moderate permeability; moderate-well drainage	Alluvial fan	Flat (0-2%)	S1	S1	S1	42	7%
IV	Aquic Haplustalfs deep; coase loamy; neutral; moderate CEC; moderate permeability; well drainage	Alluvial fan	Undulating (2-4%)	S3	S1	S1	38	6%
V	Oxyaquic Haplustalfs deep; fine loam-coase loam; neutral; moderate CEC; moderate permeability; well drainage	Mountain foot slope	Flat (0-3%)	S3	S1	S1	16	3%
VI	Fluventic Ustropepts deep; coase loamy; neutral; moderate CEC; slightly slow permeability; well drainage	Alluvial fan	Flat (0-2%)	S3	S1	S1	23	4%
VII	Typic Ustifluvents deep; fine loam-fine silty; neutral; moderate CEC; rapid permeability; well drainage	Mountain slope	Rolling (8-10%)	S3	S1	S1	50	8%
VIII	Oxyaquic Ustipsamments deep; fine loam; neutral; moderate CEC; rapid permeability	Mountain slope	Rolling (8-10%)	S3	S1	S1	14	2%
#	Unclassified						180	30%
	Total						597	100%

Source: Soil survey carried out by the local consultant under supervision of the JICA Team

Table 1.6 Summary of Farm Household Economic Survey in the Pelangan Project Area

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Respond't No. 11	Respond't No. 12	Respond't No. 13	Respond't No. 14	Respond't No. 15	Average
1	Sex and Age		Male 45	Male 35	Male 32	Male 23	Male 23	Male 45	Male 60	Male 37	Male 34	Male 23	Male 24	Male 35	Male 60	Male 65	Male 25	Male 38
2	No. of Family Member		M-2/F-1	M-0/F-2	M-3/F-3	M-0/F-0	M-1/F-1	M-2/F-4	M-1/F-4	M-4/F-2	M-1/F-2	M-0/F-2	M-0/F-2	M-0/F-2	M-0/F-3	M-1/F-3	M-3/F-1	M-2/F-2
3	Type of Side Job		Entrepren.	HC Driver	Craftman	Craftman	None	Carpenter	Craftman	None	None	None	None	Seller	Kiosk	None	Worker	
4	Own Farmland	ha	0.80	1.00	1.00	0.50	0.50	1.57	1.08	2.12	1.00	2.04	0.68	2.65	0.92	0.08	0.60	1.10
	Rented Farmland	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Yield Division	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	(Paddy field)	ha	0.80	1.00	1.00	0.50	0.50	1.50	1.00	2.00	0.85	2.00	0.62	1.00	0.00	0.00	0.50	0.88
5	Cropped Area	ha	1.60	2.00	2.00	0.95	1.50	3.00	1.82	2.00	2.28	3.55	0.79	2.60	0.48	2.95	0.92	1.90
	(Paddy)	ha	1.60	2.00	2.00	0.45	1.00	1.50	0.95	0.00	1.60	1.80	0.19	1.70	0.24	2.00	0.00	1.14
	(Palawija)	ha	0.00	0.00	0.00	0.50	0.50	1.50	0.87	2.00	0.68	1.75	0.60	0.90	0.24	0.95	0.92	0.76
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cow/Buffalo	head	1	0	0	8	3	2	4	0	3	2	2	4	2	5	2	3
	Horse	head	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Goat/Sheep	head	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
	Pig	head	0	0	0	2	2	0	5	2	1	2	1	0	0	0	0	1
	Chicken/Duck	head	9	11	11	17	10	26	90	14	0	4	43	12	5	5	8	18
7	Gross Income	Rp.'000/yr	1,470.0	2,300.0	1,330.0	2,380.0	1,957.5	7,625.0	5,792.5	1,342.5	1,381.3	1,975.0	526.3	3,587.5	915.0	1,275.0	1,692.5	2,370.0
	(Crop)	Rp.'000/yr	750.0	1,100.0	610.0	620.0	1,657.5	1,325.0	987.5	1,340.0	1,131.3	1,725.0	526.3	1,127.5	195.0	675.0	1,112.5	992.2
	(Livestock)	Rp.'000/yr	0.0	0.0	0.0	1,400.0	300.0	0.0	605.0	2.5	250.0	250.0	0.0	600.0	0.0	600.0	300.0	287.2
	(Side job)	Rp.'000/yr	720.0	1,200.0	720.0	360.0	0.0	6,300.0	4,200.0	0.0	0.0	0.0	0.0	1,860.0	720.0	0.0	280.0	1,090.7
	(Miscellaneous)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Expenditure	Rp.'000/yr	859.8	1,009.5	1,202.8	1,314.7	691.5	5,014.8	1,184.8	1,598.0	1,234.3	1,399.0	688.5	2,670.4	1,042.0	1,508.0	1,609.5	1,535.2
	(Food/drink)	Rp.'000/yr	324.0	372.0	348.0	492.0	282.0	2,889.0	396.0	870.0	612.0	504.0	414.0	840.0	798.0	119.5	900.0	677.4
	(Living)	Rp.'000/yr	262.0	234.0	461.0	588.0	119.8	818.0	133.7	205.0	140.0	367.0	106.0	1,289.0	133.3	374.0	427.0	377.2
	(Education)	Rp.'000/yr	120.0	120.0	108.0	0.0	0.0	720.0	180.0	180.0	18.0	0.0	0.0	0.0	0.0	180.0	0.0	108.4
	(Production)	Rp.'000/yr	153.8	283.5	285.8	234.7	289.7	587.8	475.1	343.0	464.3	528.0	168.5	541.4	110.7	834.5	282.5	372.2
9	Surplus/Deficit	Rp.'000/yr	610.2	1,290.5	127.2	1,065.3	1,266.0	2,610.2	4,607.7	-255.5	147.0	576.0	-162.2	917.1	-127.0	-233.0	83.0	834.8
10	Saving	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source : JICA Agro-economy Survey

Table 2.1 Estimated Evapotraspiration in Pelangan Project

Site : Pelangan
Mteorological Station : Rembiga

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	C	26.90	26.80	26.50	26.50	26.30	25.50	25.00	25.40	26.10	26.80	27.00	27.00
RH mean	%	80.00	82.00	83.00	81.00	81.00	79.00	75.00	77.00	77.00	78.00	81.00	82.00
U km/day	km/day	289.00	236.00	223.00	178.00	183.00	214.00	227.00	245.00	240.00	205.00	191.00	191.00
ea	mbar	35.28	35.07	34.44	34.44	34.02	32.46	31.51	32.27	33.60	35.07	35.49	35.49
RH/100		0.80	0.82	0.83	0.81	0.81	0.79	0.75	0.77	0.77	0.78	0.81	0.82
ed	mbar	28.22	28.76	28.59	27.90	27.56	25.64	23.63	24.85	25.87	27.35	28.75	29.10
(ea-ed)	mbar	7.06	6.31	5.85	6.54	6.46	6.82	7.88	7.42	7.73	7.72	6.74	6.39
f(u)		1.05	0.91	0.87	0.75	0.76	0.85	0.88	0.93	0.92	0.82	0.79	0.79
(1-W)		0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.25	0.24	0.24	0.24
(1-W)f(u)(ea-ed)	mm/day	1.79	1.39	1.26	1.21	1.22	1.48	1.82	1.78	1.77	1.54	1.28	1.21
Ra	mm/day	16.40	16.30	15.50	14.20	12.80	12.00	12.40	13.50	14.80	15.90	16.20	16.20
n	hr/day	5.10	5.50	5.60	6.70	6.70	6.80	7.10	7.00	6.70	6.40	6.70	5.60
N	hr/day	12.60	12.40	12.10	11.80	11.60	11.50	11.60	11.80	12.00	12.30	12.60	12.70
(0.25+0.50n/N)		0.45	0.47	0.48	0.53	0.54	0.55	0.56	0.55	0.53	0.51	0.52	0.47
Rs	mm/day	7.42	7.69	7.46	7.58	6.90	6.55	6.89	7.38	7.83	8.11	8.36	7.62
Rns	mm/day	5.94	6.15	5.97	6.07	5.52	5.24	5.52	5.90	6.27	6.49	6.69	6.10
f(T)		16.06	16.06	15.98	15.98	15.94	15.75	15.65	15.75	15.90	16.06	16.10	16.10
f(ed)		0.10	0.10	0.10	0.10	0.10	0.11	0.12	0.12	0.11	0.11	0.10	0.10
f(n/N)		0.46	0.50	0.52	0.61	0.62	0.63	0.65	0.63	0.60	0.57	0.58	0.50
Rnl=f(T)f(ed)f(n/N)	mm/day	0.76	0.80	0.83	1.01	1.04	1.13	1.24	1.16	1.07	0.96	0.93	0.79
Rn =Rns-Rnl		5.17	5.35	5.14	5.06	4.48	4.11	4.27	4.74	5.19	5.52	5.76	5.31
W		0.76	0.76	0.75	0.75	0.75	0.74	0.74	0.74	0.75	0.76	0.76	0.76
W Rn		3.92	4.05	3.88	3.81	3.37	3.06	3.16	3.52	3.89	4.18	4.37	4.03
c		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Eto	mm/day	6.29	5.99	5.64	5.52	5.05	4.99	5.47	5.83	6.23	6.30	6.21	5.76

Source : JICA Study Team estimation by Modified Penman Method based on the meteorological data at the Rembiga station.

Table 2.2 Effective Rainfall in Pelengan Project

Site : Pelangan
Meteorological Station : Sekotong

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Palawija
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	195	249	18.8%	184	129	137
February	168	226	17.0%	167	117	118
March	175	166	12.5%	123	86	93
April	166	92	6.9%	68	48	54
May	157	79	5.9%	58	41	46
June	150	45	3.4%	33	23	27
July	170	26	2.0%	19	13	16
August	181	17	1.3%	13	9	11
September	187	26	2.0%	19	13	16
October	195	60	4.5%	44	31	37
November	186	139	10.5%	103	72	81
December	179	203	15.3%	150	105	110
Total	2,109	1,328	100.0%	981	687	747

Note ;

[1] : Estimated by Modified Penman Method based on Rembiga station
[2] : Rainfall data in station compiled by DPU+Crippen (1950-1985)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 981 mm (Calculated 80 % dependable annual rainfall) x [3]
[5] : [4] x 0.70
[6] : Derived by USDA SCS Method introduced by Design Criteria KP-01, where effective storage is assumed 75 mm

Source : JICA Study Team estiamtin based on the rainfall data at Sekotong statin

Table 2.3 Irrigation Water Requirement in Pelangan Project (1/4)

Site : Pelangan
Crops : Wet Season Paddy

Item		Month (days)	Jan. 1 15	Jan. 2 16	Feb. 1 14	Feb. 2 14	Mar. 1 15	Mar. 2 16	Apr. 1 15	Apr. 2 15	May 1 15	May 2 16	Jun. 1 15	Jun. 2 15	Jul 1 15	Jul 2 16	Aug. 1 15	Aug. 2 16	Sep. 1 15	Sep. 2 15	Oct. 1 15	Oct. 2 16	Nov. 1 15	Nov. 2 15	Dec. 1 15	Dec. 2 16	Annual
I. Evapotranspiration (Eto)		mm/day	6.29	6.29	5.99	5.99	5.64	5.64	5.52	5.52	5.05	5.05	4.99	4.99	5.47	5.47	5.83	5.83	6.23	6.23	6.30	6.30	6.21	6.21	5.76	5.76	
		mm	94	101	84	84	85	90	83	83	76	81	75	75	82	88	87	93	93	93	95	101	93	93	86	92	2,107
II. Wet Season Paddy																											
(1) Proposed cropping pattern / Crop coefficient																											
- WP-1			1.10	1.10	1.05	1.05	0.95	0.00																	LP	LP	
- WP-2			LP	1.10	1.10	1.05	1.05	0.95	0.00																	LP	
- WP-3			LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
(2) Crop consumptive use (Etc)																											
- WP-1		mm	104	111	88	88	80	0																			471
- WP-2		mm		111	92	88	89	86	0																		466
- WP-3		mm			92	92	89	95	79	0																	447
(3) Land preparation (IR)																											
- WP-1		mm																							198	211	409
- WP-2		mm	203																							211	414
- WP-3		mm	203	216																							419
(4) Percolation																											
- WP-1		mm	30	32	28	28	30																				
- WP-2		mm		32	28	28	30	32																			
- WP-3		mm			28	28	30	32	30																		
(5) Water layer replacement (RW)																											
- WP-1		mm		50		50																					
- WP-2		mm			50		50																				
- WP-3		mm				50		50																			
(6) Effective rainfall (ER)		mm	62	67	59	58	41	45	24	24	20	21	12	11	6	7	4	5	6	7	15	16	36	36	51	54	687
(7) Field water requirement																											
- WP-1		mm	72	126	57	108	69	0																	147	157	736
- WP-2		mm	141	76	111	58	128	73	0																	157	744
- WP-3		mm	141	149	61	112	78	132	85	0																	758
(8) Diversion requirement		mm	181	180	118	143	141	105	43	0															75	161	1,147
		m3/ha	1,810	1,800	1,180	1,430	1,410	1,050	430	0															750	1,610	11,470

Source : JICA Study Team estimate based on the meteorological data at the Rembiga and the Sekotong station

Table 2.3 Irrigation Water Requirement in Pelangan Project (2/4)

Site : Pelangan
Crops : Dry Season Paddy

Item		Month (days)	Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
			15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)		mm/day	6.29	6.29	5.99	5.99	5.64	5.64	5.52	5.52	5.05	5.05	4.99	4.99	5.47	5.47	5.83	5.83	6.23	6.23	6.30	6.30	6.21	6.21	5.76	5.76	
		mm	94	101	84	84	85	90	83	83	76	81	75	75	82	88	87	93	93	93	95	101	93	93	86	92	2,107
II. Wet Season Paddy																											
(1) Proposed cropping pattern / Crop coefficient																											
- DP-1										LP	LP	1.10	1.10	1.05	1.05	0.95	0.00										
- DP-2											LP	LP	1.10	1.10	1.05	1.05	0.95	0.00									
- DP-3												LP	LP	1.10	1.10	1.05	1.05	0.95	0.00								
(2) Crop consumptive use (Etc)																											
- DP-1		mm										89	82	79	86	83	0										419
- DP-2		mm											82	82	86	92	83	0									426
- DP-3		mm												82	90	92	92	89	0								445
(3) Land preparation (IR)																											
- DP-1		mm								195	191																386
- DP-2		mm									191	203															394
- DP-3		mm										203	189														392
(4) Percolation																											
- DP-1		mm										32	30	30	30	32	0										
- DP-2		mm											30	30	30	32	30	0									
- DP-3		mm												30	30	32	30	32	0								
(5) Water layer replacement (RW)																											
- DP-1		mm											50		50												
- DP-2		mm												50		50											
- DP-3		mm													50		50										
(6) Effective rainfall (ER)		mm	62	67	59	58	41	45	24	24	20	21	12	11	6	7	4	5	6	7	15	16	36	36	51	54	687
(7) Field water requirement																											
- DP-1		mm								171	171	100	150	98	160	108	0										958
- DP-2		mm									171	182	100	151	110	167	109	0									991
- DP-3		mm										182	177	101	164	117	168	116	0								1,025
(8) Diversion requirement		mm								88	175	238	219	180	223	201	142	59	0								1,525
		m3/ha								880	1,750	2,380	2,190	1,800	2,230	2,010	1,420	590	0								15,250

Source : JICA Study Team estimate based on the meteorological data at the Rembiga and Sekotong station

Table 2.3 Irrigation Water Requirement in Pelangan Project (3/4)

Site : **Pelangan**
Crops : **Palawija (1/2) : Soybeans, Mungbeans and Red onion**

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	6.29	6.29	5.99	5.99	5.64	5.64	5.52	5.52	5.05	5.05	4.99	4.99	5.47	5.47	5.83	5.83	6.23	6.23	6.30	6.30	6.21	6.21	5.76	5.76	
	mm	94	101	84	84	85	90	83	83	76	81	75	75	82	88	87	93	93	93	95	101	93	93	86	92	2,107
II. Palawija(1), (2) : Soybeans and Mungbeans																										
(1) Proposed cropping pattern / Crop coefficient(Kc)								**Soybeans**										**Mungbeans**								
- Pwj(1),(2)-1								0.50	0.75	1.00	1.00	0.82	0.23					0.45	0.75	1.05	0.30					
- Pwj(1),(2)-2									0.50	0.75	1.00	1.00	0.82	0.23					0.45	0.75	1.05	0.30				
- Pwj(1),(2)-3										0.50	0.75	1.00	1.00	0.82	0.23					0.45	0.75	1.05	0.30			
(2) Crop consumptive use(Etc)																										
- Pwj(1),(2)-1	mm							41	57	81	75	61	19					42	71	106	28					
- Pwj(1),(2)-2	mm								38	61	75	75	67	20					43	76	98	28				
- Pwj(1),(2)-3	mm									40	56	75	82	72	20					45	70	98	26			
(3) Effective rainfall (ER)	mm	66	71	59	59	45	48	27	27	22	24	14	13	8	8	5	6	8	8	18	19	40	41	53	57	746
(4) Field water requirement																										
- Pwj(1),(2)-1	mm							14	35	57	61	48	11					34	53	87	0					400
- Pwj(1),(2)-2	mm								16	37	61	62	59	12					25	57	58	0				386
- Pwj(1),(2)-3	mm									16	42	62	74	64	15					26	30	57	0			386
(5) Diversion requirement	mm							10	34	73	109	115	96	51	10			23	52	113	58	38	0			781
	m3/ha							100	340	730	1,090	1,150	960	510	100			230	520	1,130	580	380	0			7,820
III. Palawija (3) : Red onion																										
(1) Proposed cropping pattern / Crop coefficient(Kc)																		**Red onion**								
- Pwj(3)-1																		0.50	0.60	0.95	0.75					
- Pwj(3)-2																			0.50	0.60	0.95	0.75				
- Pwj(3)-3																				0.50	0.60	0.95	0.75			
(2) Crop consumptive use(Etc)																										
- Pwj(3)-1	mm																	47	57	96	70					
- Pwj(3)-2	mm																		47	60	88	70				
- Pwj(3)-3	mm																			50	56	88	65			
(3) Effective rainfall (ER)	mm	66	71	59	59	45	48	27	27	22	24	14	13	8	8	5	6	8	8	18	19	40	41	53	57	746
(4) Field water requirement																										
- Pwj(3)-1	mm																	39	39	77	30					184
- Pwj(3)-2	mm																		29	41	48	29				148
- Pwj(3)-3	mm																			31	16	47	12			107
(5) Diversion requirement	mm																	26	45	100	63	51	8			292
	m3/ha																	260	450	1,000	630	510	80			2,930

Source : JICA Study Team estimate based on the meteorological data at the Rembiga and Sekotong station

Table 2.3 Irrigation Water Requirement in Pelangan Project (4/4)

Site : Pelangan
Crops : Palawija (2/2) : Mungbeans and Tomato

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
	Month (days)	15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	6.29	6.29	5.99	5.99	5.64	5.64	5.52	5.52	5.05	5.05	4.99	4.99	5.47	5.47	5.83	5.83	6.23	6.23	6.30	6.30	6.21	6.21	5.76	5.76	
	mm	94	101	84	84	85	90	83	83	76	81	75	75	82	88	87	93	93	93	95	101	93	93	86	92	2,107
II. Palawija(4), (5) : Mungbeans and Tomato																										
(1) Proposed cropping pattern / Crop coefficient(Kc)								**Mungbeans**								**Tomato**										
- Pwj(4),(5)-1								0.45	0.75	1.05	0.30					0.45	0.75	1.05	1.05	0.80	0.60					
- Pwj(4),(5)-2									0.45	0.75	1.05	0.30					0.45	0.75	1.05	1.05	0.80	0.60				
- Pwj(4),(5)-3										0.45	0.75	1.05	0.30					0.45	0.75	1.05	1.05	0.80	0.60			
(2) Crop consumptive use(Etc)																										
- Pwj(4),(5)-1	mm								37	57	85	22					42	70	98	99	81	56				
- Pwj(4),(5)-2	mm									34	61	79	22					42	70	99	106	75	56			
- Pwj(4),(5)-3	mm										36	56	79	25					42	71	106	98	75	52		
(3) Effective rainfall (ER)	mm	66	71	59	59	45	48	27	27	22	24	14	13	8	8	5	6	8	8	18	19	40	41	53	57	746
(4) Field water requirement																										
- Pwj(4),(5)-1	mm								10	35	61	8					36	62	90	81	62	16				461
- Pwj(4),(5)-2	mm									12	37	65	9					34	62	81	87	35	15			436
- Pwj(4),(5)-3	mm										12	42	66	17					34	53	87	58	34	0		402
(5) Diversion requirement	mm								7	31	73	77	50	11			24	64	124	144	157	72	32	0		866
	m3/ha								70	310	730	770	500	110			240	640	1,240	1,440	1,570	720	320	0		8,660

Source : JICA Study Team estimate based on the meteorological data at the Rembiga and Sekotong station

Table 3.1 Estimated Catchment Rainfall at Pelangan Embung SIte

Unit : mm

year	Jan		Feb		Mar.		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1960	230	230	183	183	11	11	47	47	65	65	0	0	37	37	0	0	12	12	2	2	58	58	82	82	1,454
1961	125	125	130	130	151	151	72	72	7	7	0	0	0	0	0	0	0	0	12	12	106	106	30	30	1,266
1962	132	132	99	99	35	35	35	35	65	65	0	0	0	0	27	27	0	0	31	31	8	8	147	147	1,158
1963	325	325	28	28	48	48	34	34	0	0	0	0	0	0	0	0	10	10	25	25	10	10	82	82	1,124
1964	67	67	104	104	121	121	33	33	15	15	13	13	0	0	0	0	29	29	96	96	116	116	109	109	1,406
1965	160	160	55	55	66	66	11	11	0	0	0	0	0	0	0	0	0	0	4	4	53	53	72	72	842
1966	42	42	169	169	63	63	41	41	0	0	0	0	0	0	0	0	7	7	0	0	80	80	104	104	1,012
1967	194	194	82	82	73	73	42	42	0	0	0	0	0	0	0	0	0	0	6	6	41	41	144	144	1,164
1968	237	237	156	156	55	55	55	55	69	69	58	58	53	53	24	24	3	3	32	32	49	49	170	170	1,922
1969	45	45	53	53	52	52	86	86	0	0	6	6	0	0	0	0	1	1	20	20	41	41	6	6	620
1970	67	67	94	94	16	16	30	30	70	70	18	18	0	0	0	0	18	18	10	10	51	51	52	52	852
1971	84	84	77	77	59	59	23	23	17	17	0	0	0	0	0	0	27	27	34	34	57	57	29	29	814
1972	57	57	79	79	245	245	19	19	50	50	0	0	0	0	0	0	0	0	0	0	37	37	105	105	1,184
1973	70	70	105	105	70	70	70	70	103	103	17	17	5	5	0	0	50	50	61	61	41	41	98	98	1,380
1974	127	127	132	132	190	190	0	0	21	21	0	0	3	3	35	35	34	34	47	47	117	117	137	137	1,686
1975	91	91	228	228	178	178	61	61	132	132	0	0	0	0	0	0	18	18	138	138	127	127	155	155	2,256
1976	116	116	18	18	45	45	0	0	0	0	15	15	0	0	0	0	0	0	39	39	44	44	25	25	604
1977	219	219	284	284	116	116	11	11	0	0	18	18	0	0	0	0	0	0	0	0	20	20	56	56	1,448
1978	153	153	96	96	76	76	75	75	87	87	136	136	74	74	51	51	72	72	33	33	107	107	162	162	2,244
1979	99	99	95	95	121	121	75	75	95	95	35	35	0	0	0	0	53	53	35	35	64	64	71	71	1,486
1980	191	191	139	139	86	86	95	95	12	12	0	0	0	0	0	0	3	3	4	4	150	150	161	161	1,682
1981	129	129	120	120	80	80	89	89	59	59	20	20	69	69	34	34	26	26	28	28	167	167	100	100	1,842
1982	123	123	68	68	53	53	45	45	0	0	0	0	0	0	0	0	0	0	3	3	10	10	113	113	830
1983	38	38	73	73	20	20	23	23	100	100	1	1	0	0	0	0	0	0	89	89	96	96	80	80	1,040
1984	171	171	87	87	124	124	51	51	43	43	0	0	0	0	0	0	74	74	47	47	61	61	100	100	1,516
1985	48	48	213	213	191	191	74	74	17	17	5	5	0	0	0	0	0	0	5	5	100	100	67	67	1,440
Mean	128	128	114	114	90	90	46	46	40	40	13	13	9	9	7	7	17	17	31	31	70	70	95	95	1,318

Table 3.2 Estimated Discharge at Pelangan Embung Site

Unit : 1000 m3

year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1960	4,232	4,232	3,367	3,367	0	0	865	865	1,196	1,196	0	0	681	681	0	0	0	0	0	0	1,067	1,067	1,509	1,509	25,834
1961	2,300	2,300	2,392	2,392	2,778	2,778	1,325	1,325	0	0	0	0	0	0	0	0	0	0	0	0	1,950	1,950	552	552	22,594
1962	2,429	2,429	1,822	1,822	644	644	644	644	1,196	1,196	0	0	0	0	497	497	0	0	570	570	0	0	2,705	2,705	21,014
1963	5,980	5,980	515	515	883	883	626	626	0	0	0	0	0	0	0	0	0	0	460	460	0	0	1,509	1,509	19,946
1964	1,233	1,233	1,914	1,914	2,226	2,226	607	607	0	0	0	0	0	0	0	0	534	534	1,766	1,766	2,134	2,134	2,006	2,006	24,840
1965	2,944	2,944	1,012	1,012	1,214	1,214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	975	975	1,325	1,325	14,940
1966	773	773	3,110	3,110	1,159	1,159	754	754	0	0	0	0	0	0	0	0	0	0	0	0	1,472	1,472	1,914	1,914	18,364
1967	3,570	3,570	1,509	1,509	1,343	1,343	773	773	0	0	0	0	0	0	0	0	0	0	0	0	754	754	2,650	2,650	21,198
1968	4,361	4,361	2,870	2,870	1,012	1,012	1,012	1,012	1,270	1,270	1,067	1,067	975	975	442	442	0	0	589	589	902	902	3,128	3,128	35,256
1969	828	828	975	975	957	957	1,582	1,582	0	0	0	0	0	0	0	0	0	0	0	0	754	754	0	0	10,192
1970	1,233	1,233	1,730	1,730	0	0	552	552	1,288	1,288	0	0	0	0	0	0	0	0	0	0	938	938	957	957	13,396
1971	1,546	1,546	1,417	1,417	1,086	1,086	423	423	0	0	0	0	0	0	0	0	497	497	626	626	1,049	1,049	534	534	14,356
1972	1,049	1,049	1,454	1,454	4,508	4,508	0	0	920	920	0	0	0	0	0	0	0	0	0	0	681	681	1,932	1,932	21,088
1973	1,288	1,288	1,932	1,932	1,288	1,288	1,288	1,288	1,895	1,895	0	0	0	0	0	0	920	920	1,122	1,122	754	754	1,803	1,803	24,580
1974	2,337	2,337	2,429	2,429	3,496	3,496	0	0	386	386	0	0	0	0	644	644	626	626	865	865	2,153	2,153	2,521	2,521	30,914
1975	1,674	1,674	4,195	4,195	3,275	3,275	1,122	1,122	2,429	2,429	0	0	0	0	0	0	0	0	2,539	2,539	2,337	2,337	2,852	2,852	40,846
1976	2,134	2,134	0	0	828	828	0	0	0	0	0	0	0	0	0	0	0	0	718	718	810	810	460	460	9,900
1977	4,030	4,030	5,226	5,226	2,134	2,134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,030	1,030	24,840
1978	2,815	2,815	1,766	1,766	1,398	1,398	1,380	1,380	1,601	1,601	2,502	2,502	1,362	1,362	938	938	1,325	1,325	607	607	1,969	1,969	2,981	2,981	41,288
1979	1,822	1,822	1,748	1,748	2,226	2,226	1,380	1,380	1,748	1,748	644	644	0	0	0	0	975	975	644	644	1,178	1,178	1,306	1,306	27,342
1980	3,514	3,514	2,558	2,558	1,582	1,582	1,748	1,748	0	0	0	0	0	0	0	0	0	0	0	0	2,760	2,760	2,962	2,962	30,248
1981	2,374	2,374	2,208	2,208	1,472	1,472	1,638	1,638	1,086	1,086	0	0	1,270	1,270	626	626	478	478	515	515	3,073	3,073	1,840	1,840	33,160
1982	2,263	2,263	1,251	1,251	975	975	828	828	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,079	2,079	14,792
1983	699	699	1,343	1,343	0	0	423	423	1,840	1,840	0	0	0	0	0	0	0	0	1,638	1,638	1,766	1,766	1,472	1,472	18,362
1984	3,146	3,146	1,601	1,601	2,282	2,282	938	938	791	791	0	0	0	0	0	0	1,362	1,362	865	865	1,122	1,122	1,840	1,840	27,894
1985	883	883	3,919	3,919	3,514	3,514	1,362	1,362	0	0	0	0	0	0	0	0	0	0	0	0	1,840	1,840	1,233	1,233	25,502
Mean	2,364	2,364	2,087	2,087	1,626	1,626	818	818	679	679	162	162	165	165	121	121	258	258	520	520	1,248	1,248	1,735	1,735	23,565
	4,727		4,174		3,252		1,636		1,357		324		330		242		517		1,040		2,495		3,469		

Table 3.3 Probable Flood Discharge at Pelangan Embung Site

Characteristics of the catchment area								
Catchment Area	(km2)	46.00						
Eelevation at Dam Site (1)	(m)	20						
Maximum elevation in the catchment area (2)	(m)	350						
Height (3)=(2)-(1)	(h)	330						
Length of Catchment Area (1)	(m)	8,000						
Flow velocity	W2 (km/hr)	10.63						
Time of concentration	T2 (hrs)	0.75						
Probable Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	88	117	138	160	191	217	244
Rainfall intensity within the time of concentration	(mm)	21	28	32	38	45	51	57
Probable Flood Discharge	(m3/s)	212	281	332	385	459	522	587
Specific Discharge	(m3/s/km2)	5	6	7	8	10	11	13

To estimate design rainfall, the Log Pearson III method is adopted.
The rational method is adopted for estimation of the design flood discharge.
C = 0.8 is used to estimate designed flood discharge by the rational method.

Table 3.4 Result of Water Quality Test in Pelangan Embung Site

DESCRIPTION	UNIT	1 Upstream of proposed embung	2 Embung Site	3 Embung Site	4 downstream of proposed embung	Max. Limit of B Class by GR. NO. 20/1990
I. PHYSICS						
1 Temperature	C	29.00	30.00	31.00	29.00	Normal water temperature
2 Dissolved solid matter	mg/liter	456.00	498.00	444.00	428.00	1000
3 Electric Conductivety	umhos/cm	618.00	678.00	604.00	582.00	-
II. CHEMISTRY						
a. Unorganic chemistry						
1 Mercury	mg/liter	0.00	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.00	0.00	0.00	0.00	0.5
3 Aroenic	mg/liter	-	-	-	-	0.05
4 Barium	mg/liter	-	-	-	-	5
5 Ferro	mg/liter	0.00	0.00	0.00	0.00	1
6 Fluoride	mg/liter	0.68	0.75	0.18	0.78	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	49.70	50.40	62.50	49.10	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.00	0.00	0.00	0.00	0.5
11 Nitrate, N	mg/liter	0.71	0.00	0.00	0.00	10
12 Nitric, N	mg/liter	0.00	0.01	0.00	0.00	1
13 Dissolved Oxygen	mg/liter	8.86	8.96	8.78	7.53	*
14 pH	-	8.00	7.70	7.70	0.50	5-9
15 Selenium	mg/liter	-	-	-	-	0.01
16 Zinc	mg/liter	0.00	0.00	0.00	0.00	5
17 Cyanide	mg/liter	0.00	0.00	0.00	0.00	0.1
18 Sulphate	mg/liter	119.00	139.00	136.00	129.00	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.00	0.01	0.01	0.1
b. Organic Chemistry						
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	0.00	0.00	0.00	0.00	0.001
6 Heptachlor and Heptachlor Epoxide	mg/liter	-	-	-	-	0.018
7 Carbon Cloroform Ekiract	mg/liter	-	-	-	-	0.5
8 Lindane	mg/liter	0.00	0.00	0.00	0.00	0.056
9 Methoxychlor	mg/liter	-	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	0.00	0.00	0.00	0.00	0.1
12 PCB	mg/liter	-	-	-	-	Nil
13 Senyawa atife biru (Sulfaktan)	mg/liter	0.04	0.03	0.04	0.04	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.00	0.005
III MICRO BIOLOGY						
1 Coliform tinja	per 100 ml	18,000	14,000	18,000	11,000	2,000
2 Total Coliform	per 100 ml	24,000	17,000	28,000	24,000	10,000

NOTE:
* = The water level shall be more than or equal to 6.
mg = miligram
ml = Milimeter
Bq = Bequerel

Heavy metals are classified into dissolved matter.

Source : JICA's Water Quality Test

Table 7.1 Summary of Construction Cost in Pelangan Project

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	618
1.2 Embung Construction	
1) Main dam	6,713
2) Spillway	3,857
3) Diversion Tunnel	0
4) Seepage protection works	0
5) Miscellaneous	1,057
Sub-total of 1.2	11,627
1.3 Irrigation Facilities	114
1.4 Domestic Water Supply	623
1.5 Embung Operation and Maintenance Road	0
Sub-total of I.	12,982
II. Administration Cost	649
III. Engineering Services	1,947
Sub-total of I, II & III	15,579
IV. Physical Contingency	2,337
Sub-total of I, II, II, & IV	17,915
V. Contract Tax	1,727
VI. Land Acquisition Cost	65
Sub-total I, II, III, IV, V & VI	19,707
VII. Price Contingency	3,941
GRAND TOTAL	23,648

Table 7.2 Direct Construction Cost in Pelangan Project(1/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Dam				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	31,200	12,480
2) Excavation, common	m3	3,500	77,900	272,650
, weathered rock	m3	7,500	46,700	350,250
, rock	m3	11,500	31,400	361,100
3) Embankment, impervious soil	m3	8,000	113,600	908,800
, filter	m3	12,000	55,300	663,600
, transition	m3	12,000	53,600	643,200
, random material	m3	6,000	399,400	2,396,400
4) Stone masonry	m3	80,000	0	0
5) Rip-rap protection	m3	15,000	14,900	223,500
1.2 Grouting	m	71,000	7,900	560,900
1.3 Other miscellaneous works				319,644
Sub-total of 1.				6,712,524
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	13,200	5,280
2) Excavation, common soil	m3	3,500	17,300	60,550
, weathered rock	m3	7,500	28,800	216,000
, rock	m3	11,500	69,200	795,800
3) Backfill	m3	5,200	3,900	20,280
2.2 Concrete works				
1) Concrete - A	m3	250,000	510	127,500
2) Concrete - B	m3	170,000	9,680	1,645,600
3) Reinforcement bar	ton	1,500,000	26	39,000
4) Form	m2	15,000	50,900	763,500
2.3 Other miscellaneous works	L.S			183,676
Sub-total of 2.				3,857,186
3. Miscellaneous & Others				1,056,971
Total - I.				11,626,680
II. Irrigation Facilities				
1. Canal works (including the rehabilitation works)				
1.1 Earth works				
1) Clearing	m2	400	0	0
2) Excavation	m3	5,000	0	0
3) Embankment	m3	6,300	0	0
1.2 Stone masonry	m3	80,000	1,300	104,000
Sub-total of 1.				104,000
2. Related structures				
2.1 Turnout	nos.	2,600,000		0
2.2 Syphon	nos.	5,500,000		0
2.3 Aqueduct	nos.	6,000,000		0
2.3 Cross drain	nos.	4,700,000		0
2.4 Irrigation division box	nos.	900,000		0
2.5 Division box for livestock	nos.	1,200,000		
Sub-total of 2.				0

Table 7.2 Direct Construction Cost in Pelangan Project(2/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
3. Miscellaneous & Others	L.S			10,400
Total - II				114,400
III. Domestic Water Supply				
1. Pipe line				
1.1 Earth works				
1) Clearing	m2	400	6,700	2,680
2) Excavation	m3	5,000	4,200	21,000
3) Backfill	m3	5,200	4,000	20,800
1.2 Pipe line setting works				
1) Dia 75 mm	m	13,300		0
2) Dia 150 mm	m	33,200	7,500	249,000
1.3 Pipe line related structures				
1) Check valve		624,000	4	2,496
2) Air valve		506,000	4	2,024
3) Drainage valve		1,036,000	3	3,108
Sub-total of 1.				301,108
2. Division Boxes				
1) Division box for inhabitants	nos.	6,990,000	38	265,620
2) Division box for livestock	nos.	1,130,000		0
Sub-total of 2.				265,620
3. Miscellaneous & Others	L.S			56,673
Total - III.				623,401
GRAND TOTAL				12,364,481

Table 8.1 Economic Construction Costs and Annual Disburement Schedule

Pelangan Project (Unit : Rp. million)

Item	SCF	Total cost	1st year	2nd year	3rd year
1 Direct Construction Cost		8,466	220	3,685	4,561
1) Preparatory Works	0.71	439	220	219	0
2) Dam Construction					
- Main dam	0.71	4,766	0	2,383	2,383
- Spillway	0.71	2,738	0	821	1,917
- Diversion tunnel	0.71	0	0	0	0
- Seepage protection works	0.71	0	0	0	0
Sub-total		7,504	0	3,204	4,300
3) Irrigation Facilities	0.71	81	0	41	40
4) Domestic Water Supply System	0.71	442	0	221	221
5) Dam O & M Road	0.71	0	0	0	0
2 Administration Cost	0.90	584	15	254	315
3 Engineering Services	0.90	805	323	241	241
4 Physical Contingency		1,270	33	553	684
Total		11,125	591	4,733	5,801

Note : Standard Conversion Factors (SFC). Source ; Pedoman Pengamatan dan Evaluasi Proyek-Proyek Pengairan, Direktorato Jeneral Pengairan, 1985

Table 8.2 Financial and Economic Prices of Farm Inputs and Outputs in NTB

Item		Unit	Lombok		Sumbawa	
			Financial Price *1	Economic Price *2	Financial Price *1	Economic Price *2
1 Farm Products						
Paddy *3		kg	280	397	260	394
Maize *3		kg	200	220	200	215
Mungbeans *3		kg	1,000	906	1,000	901
Soybeans *3		kg	900	647	900	642
Red onion *4		kg	900	704	800	699
Tobacco *5		kg	900	522	900	521
2 Seeds						
Paddy	Certified	kg	605	605	605	605
	Own	kg	-	325	-	325
Maize	Certified	kg	922	922	922	922
	Own	kg	-	297	-	297
Mungbeans	Certified	kg	1,383	1,383	1,383	1,383
	Own	kg	-	893	-	893
Soybeans	Certified	kg	617	617	617	617
	Own	kg	-	606	-	606
Red onion		kg	850	850	850	850
Tobacco		kg	25,000	25,000	25,000	25,000
3 Fertilisers						
Urea		kg	350	414	350	419
TSP		kg	400	486	400	491
KCl		kg	400	416	400	421
4 Agro-chemicals						
Insecticides	Liquid type	lit	10,000	10,000	10,000	10,000
	Powder type	kg	3,000	3,000	3,000	3,000
Rodenticides		kg	5,500	5,500	5,500	5,500
5 Labour						
Hired labour *6		man-day	3,000	2,250	2,500	1,875
Family labour		man-day	-	2,250	-	1,875
6 Draft Animal						
Hired		head-day	6,000	6,000	5,000	5,000
Own		head-day	-	6,000	-	5,000
7 Farm Machinery						
Tractor		ha	250,000	250,000	200,000	200,000

Remarks : *1 ; As of 1994

*2 ; Projected prices in 2005 at 1994 constant prices

*3 ; Dry grain

*4 ; Fresh

*5 ; Fresh leaves

*6 ; Economic conversionfactor is 0.75.

Table 8.3 Economic Crop Budget per Ha

Pelangan Project

Item		Q'ty of Unit	Value (Rp.)	Without Project: Paddy (Irrigated) Q'ty	Paddy (Irrigated) Am't (Rp.)	Paddy (Rainfed) Q'ty	Paddy (Rainfed) Am't (Rp.)	Maize (Rainfed) Q'ty	Maize (Rainfed) Am't (Rp.)	Mungbean (2nd crop) (Rainfed) Q'ty	Mungbean (2nd crop) (Rainfed) Am't (Rp.)	With Project: Paddy (1st crop) (Irrigated) Q'ty	Paddy (1st crop) (Irrigated) Am't (Rp.)	Paddy (2nd crop) (Irrigated) Q'ty	Paddy (2nd crop) (Irrigated) Am't (Rp.)	Mungbean (Irrigated) Q'ty	Mungbean (Irrigated) Am't (Rp.)	Red Onion (Irrigated) Q'ty	Red Onion (Irrigated) Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	397	3,000	1,191,000	2,000	794,000	0	0	0	0	4,500	1,786,500	4,500	1,786,500	0	0	0	0
Maize		kg	220	0	0	0	0	1,300	286,000	0	0	0	0	0	0	0	0		0
Mungbean		kg	906	0	0	0	0	0	0	500	453,000	0	0	0	0	1,200	1,087,200	0	0
Red onion		kg	704	0	0	0	0	0	0		0	0	0	0	0	0	0	7,500	5,280,000
2 Production Cost																			
Seed																			
Paddy	Certified	kg	605	50	30,250	0	0	0	0	0	0	25	15,125	25	15,125	0	0	0	0
	Own	kg	325	0	0	50	16,250	0	0	0	0	0	0	0	0	0	0	0	0
Maize	Certified	kg	922	0	0	0	0	5	4,610	0	0	0	0	0	0	0	0	0	0
	Own	kg	297	0	0	0	0	20	5,940	0	0	0	0	0	0	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	7	9,681	0	0	0	0	10	13,830	0	0
	Own	kg	893	0	0	0	0	0	0	28	25,004	0	0	0	0	20	17,860	0	0
Red onion	Certified	kg	850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	1,700,000
Fertiliser																			
Urea		kg	414	225	93,150	150	62,100	50	20,700	25	10,350	300	124,200	300	124,200	75	31,050	300	124,200
TSP		kg	486	75	36,450	50	24,300	50	24,300	50	24,300	100	48,600	100	48,600	100	48,600	200	97,200
KCl		kg	416	35	14,560	0	0	0	0	25	10,400	50	20,800	50	20,800	50	20,800	100	41,600
Agro-chemicals																			
Insecticide	Lquid	lit	10,000	2.0	20,000	0.5	5,000	0.0	0	0.0	0	2.0	20,000	1.0	10,000	2.0	20,000	10.0	100,000
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	2.0	11,000	0.5	2,750	0.0	0	0.0	0	2.0	11,000	2.0	11,000	1.0	5,500	3.0	16,500
Labor																			
Family		md	2,250	127	285,750	65	146,250	32	72,000	25	56,250	172	387,000	167	375,750	80	180,000	151	339,750
Hired		md	2,250	13	29,250	10	22,500	0	0	0	0	13	29,250	13	29,250	0	0	99	222,750
Draft Animal																			
Family		ad	6,000	20	120,000	10	60,000	5	30,000	5	30,000	20	120,000	20	120,000	10	60,000	20	120,000
Hired		ad	6,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tractor		ha	250,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total production cost					640,410		339,150		157,550		165,985		775,975		754,725		397,640		2,762,000
3 Net Production Value					550,590		454,850		128,450		287,015		1,010,525		1,031,775		689,560		2,518,000

Table 8.4 Economic Costs and Benefits Flow

Pelangan Project Unit : Million Rp.

Year	Cost				Benefit			Increment
	Capital	Replace	O&M	Total	Irrigation	Negative	Total	
1.	591	0	0	591	0	-2	-2	-593
2.	4,733	0	0	4,733	0	-2	-2	-4,735
3.	5,801	0	0	5,801	0	-2	-2	-5,803
4.	0	0	45	45	474	-1	473	428
5.	0	0	45	45	553	0	553	508
6.	0	0	45	45	632	0	632	587
7.	0	0	45	45	711	0	711	666
8.	0	0	45	45	790	0	790	745
9.	0	0	45	45	790	0	790	745
10.	0	0	45	45	790	0	790	745
11.	0	0	45	45	790	0	790	745
12.	0	0	45	45	790	0	790	745
13.	0	0	45	45	790	0	790	745
14.	0	0	45	45	790	0	790	745
15.	0	0	45	45	790	0	790	745
16.	0	0	45	45	790	0	790	745
17.	0	0	45	45	790	0	790	745
18.	0	0	45	45	790	0	790	745
19.	0	0	45	45	790	0	790	745
20.	0	0	45	45	790	0	790	745
21.	0	0	45	45	790	0	790	745
22.	0	0	45	45	790	0	790	745
23.	0	0	45	45	790	0	790	745
24.	0	0	45	45	790	0	790	745
25.	0	0	45	45	790	0	790	745
26.	0	0	45	45	790	0	790	745
27.	0	0	45	45	790	0	790	745
28.	0	0	45	45	790	0	790	745

EIRR = 3.6 %

Table 8.5 Financial Crop Budget per Ha

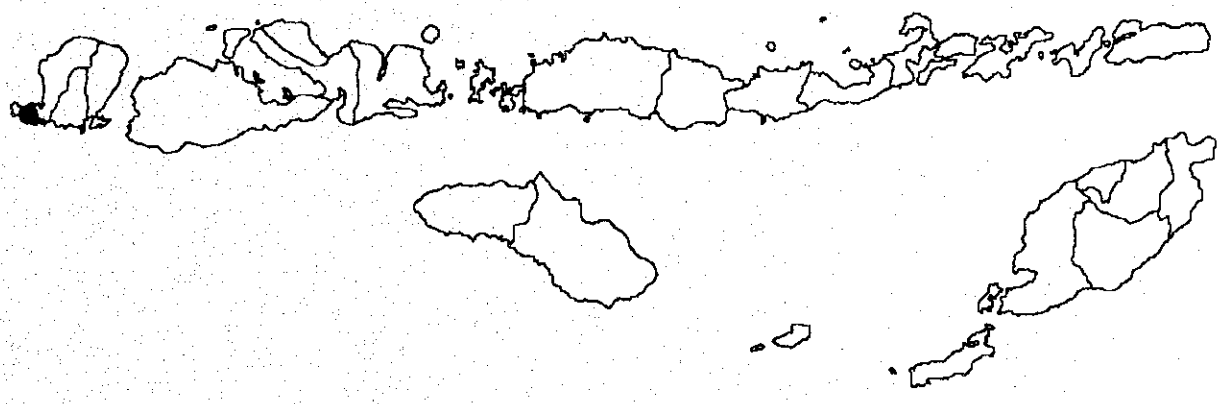
Pelangan Project

Item		Q'ty of Unit	Value (Rp.)	Without Project: Paddy (Irrigated) Q'ty	Paddy (Irrigated) Am't (Rp.)	Paddy (Rainfed) Q'ty	Paddy (Rainfed) Am't (Rp.)	Maize (Rainfed) Q'ty	Maize (Rainfed) Am't (Rp.)	Mungbean (2nd crop) (Rainfed) Q'ty	Mungbean (2nd crop) (Rainfed) Am't (Rp.)	With Project: Paddy (1st crop) (Irrigated) Q'ty	Paddy (1st crop) (Irrigated) Am't (Rp.)	Paddy (2nd crop) (Irrigated) Q'ty	Paddy (2nd crop) (Irrigated) Am't (Rp.)	Mungbean (Irrigated) Q'ty	Mungbean (Irrigated) Am't (Rp.)	Red Onion (Irrigated) Q'ty	Red Onion (Irrigated) Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	280	3,000	840,000	2,000	560,000	0	0	0	0	4,500	1,260,000	4,500	1,260,000	0	0	0	0
Maize		kg	200	0	0	0	0	1,300	260,000	0	0	0	0	0	0	0	0		0
Mungbean		kg	1,000	0	0	0	0	0	0	500	500,000	0	0	0	0	1,200	1,200,000	0	0
Red onion		kg	900	0	0	0	0	0	0		0	0	0	0	0	0	0	7,500	6,750,000
2 Production Cost																			
Seed																			
Paddy	Certified	kg	605	50	30,250	0	0	0	0	0	0	25	15,125	25	15,125	0	0	0	0
	Own	kg	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0
Maize	Certified	kg	922	0	0	0	0	5	4,610	0	0	0	0	0	0	0	0	0	0
	Own	kg	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	7	9,681	0	0	0	0	10	13,830	0	0
	Own	kg	0	0	0	0	0	0	0	28	0	0	0	0	0	20	0	0	0
Red onion	Certified	kg	850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	1,700,000
Fertiliser																			
Urea		kg	350	225	78,750	150	52,500	50	17,500	25	8,750	300	105,000	300	105,000	75	26,250	300	105,000
TSP		kg	400	75	30,000	50	20,000	50	20,000	50	20,000	100	40,000	100	40,000	100	40,000	200	80,000
KCl		kg	400	35	14,000	0	0	0	0	25	10,000	50	20,000	50	20,000	50	20,000	100	40,000
Agro-chemicals																			
Insecticide	Lquid	lit	10,000	2.0	20,000	0.5	5,000	0.0	0	0.0	0	2.0	20,000	1.0	10,000	2.0	20,000	10.0	100,000
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rodemicide		kg	5,500	2.0	11,000	0.5	2,750	0.0	0	0.0	0	2.0	11,000	2.0	11,000	1.0	5,500	3.0	16,500
Labor																			
Family		md	0	127	0	65	0	32	0	25	0	172	0	167	0	80	0	151	0
Hired		md	3,000	13	39,000	10	30,000	0	0	0	0	13	39,000	13	39,000	0	0	99	297,000
Draft Animal																			
Family		ad	0	20	0	10	0	5	0	5	0	20	0	20	0	10	0	20	0
Hired		ad	6,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tractor		ha	250,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total production cost					223,000		110,250		42,110		48,431		250,125		240,125		125,580		2,338,500
3 Net Production Value					617,000		449,750		217,890		451,569		1,009,875		1,019,875		1,074,420		4,411,500

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Pelangan Embung Development Project

Figures



Legend (Present Land Use/Soils)

Present Land Use		Soils
PI	Paddy Field, Irrigated	I
PR	Paddy Field, Rainfed	II
U	Upland	III
T	Tree Crops	IV
B	Bush/Scrub/Grassland	V
R	Residential	VI
C	Cemetery	VII
O	Others	VIII
		#

▲ No — Soil Test Pit with Sampling

△ No — Soil Test Pit without Sampling

—··—··— Boundary of Beneficiary Area

0 200 400 600 800 1000 m

SCALE 1 : 20,000

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

PELANGAN

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 1.1 Present Land Use and Soils (Pelangan)

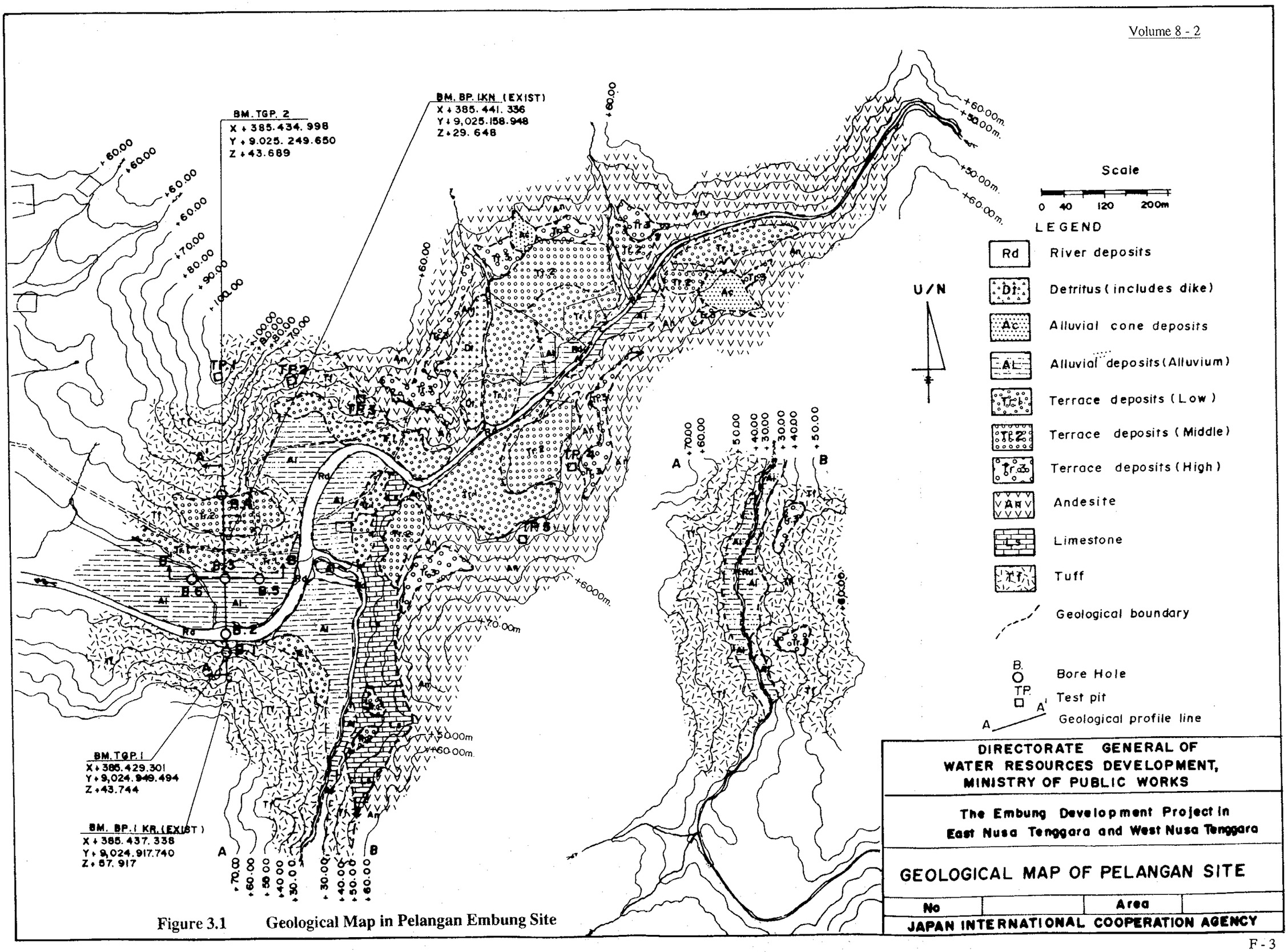


Figure 3.1 Geological Map in Pelangan Embung Site

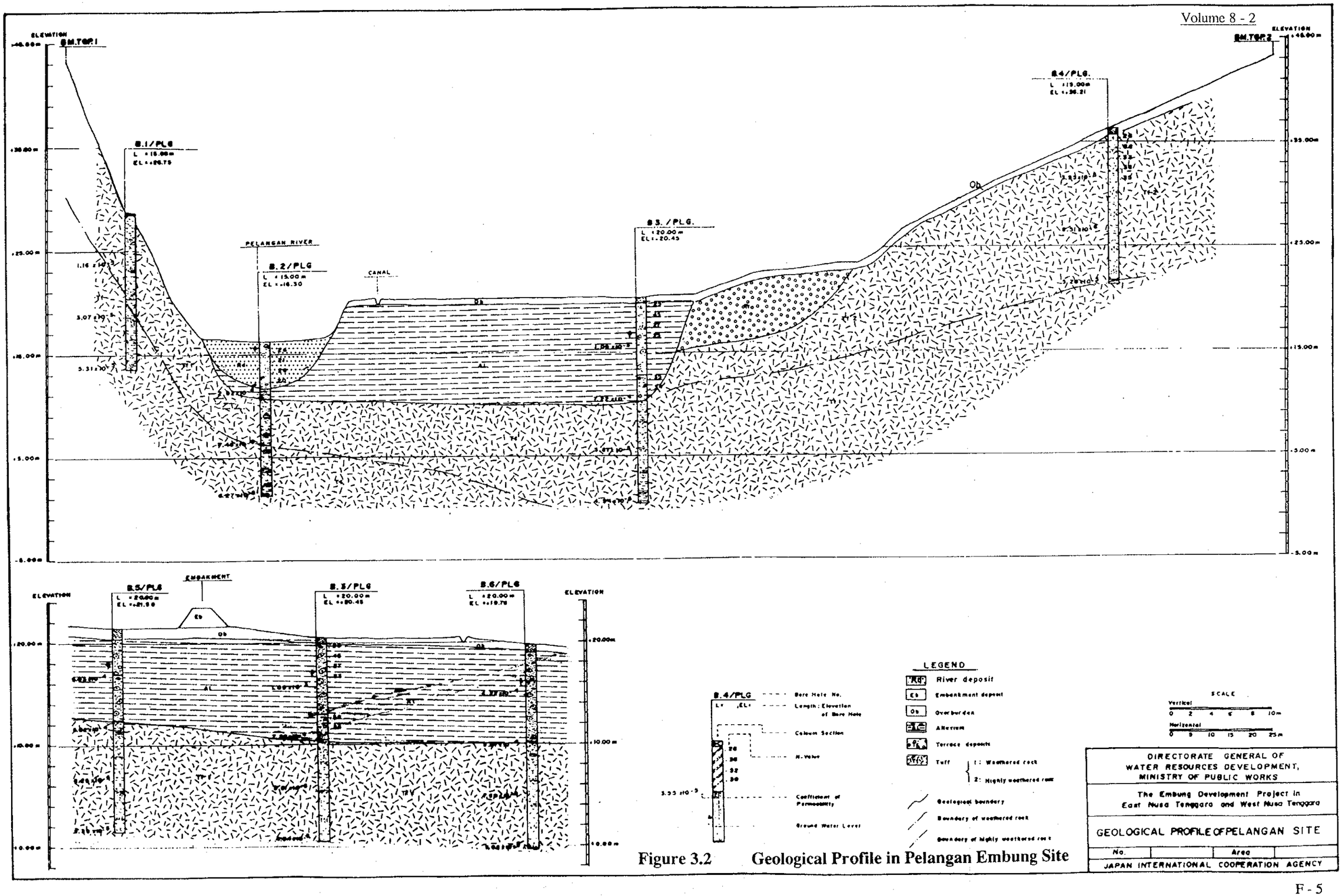


Figure 3.2 Geological Profile in Pelangan Embung Site

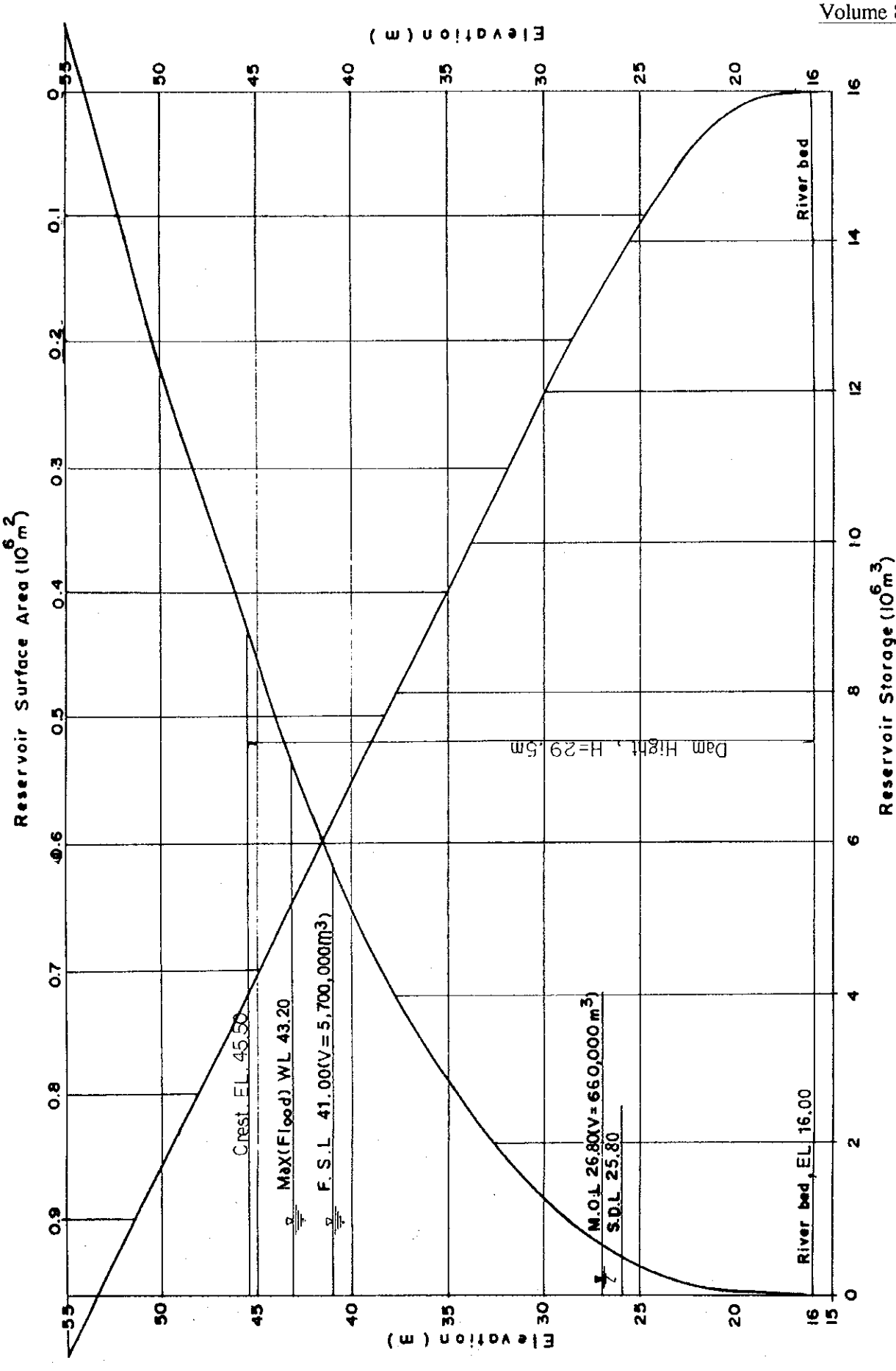


Figure 4.1 Reservoir Storage Curve in Pelangan Embung

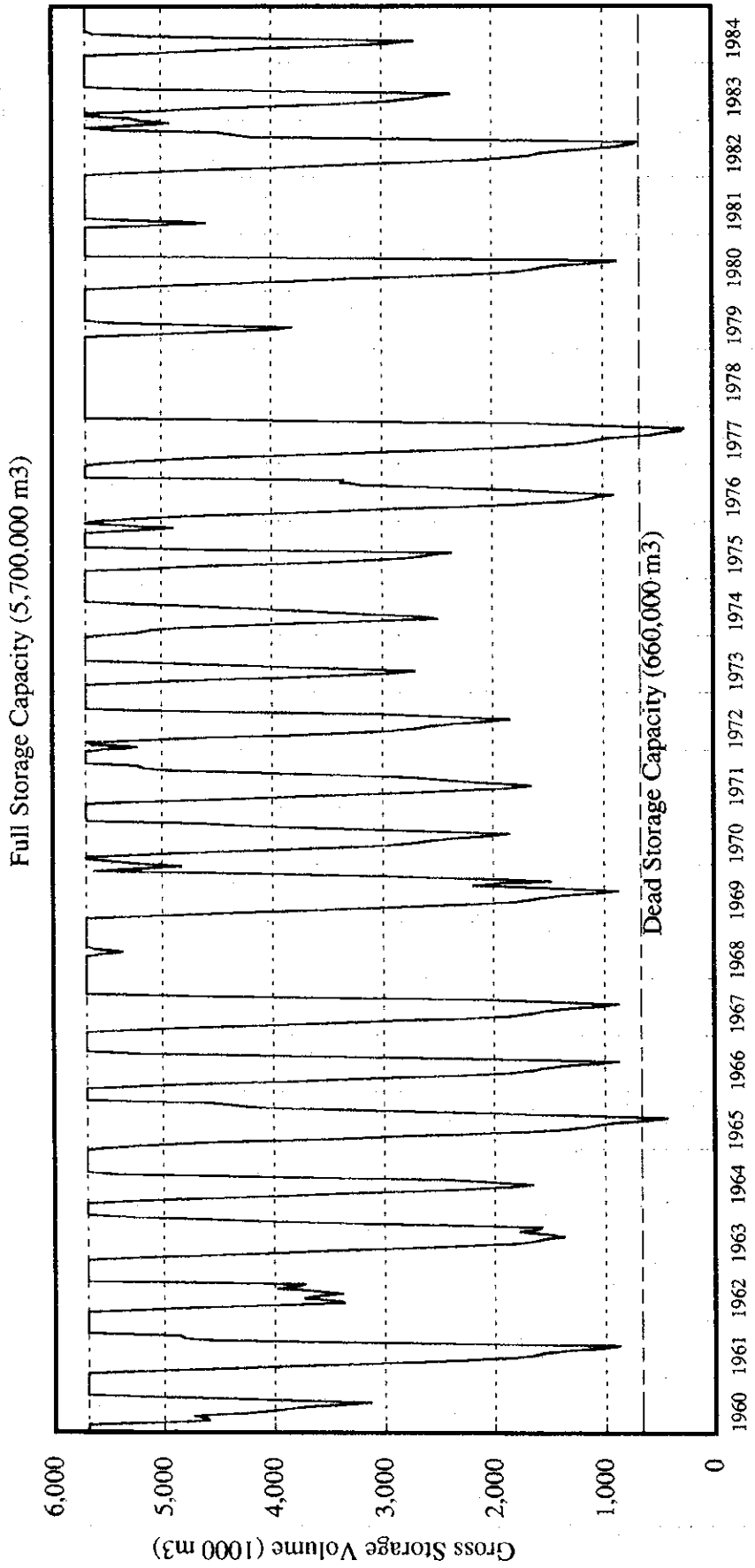
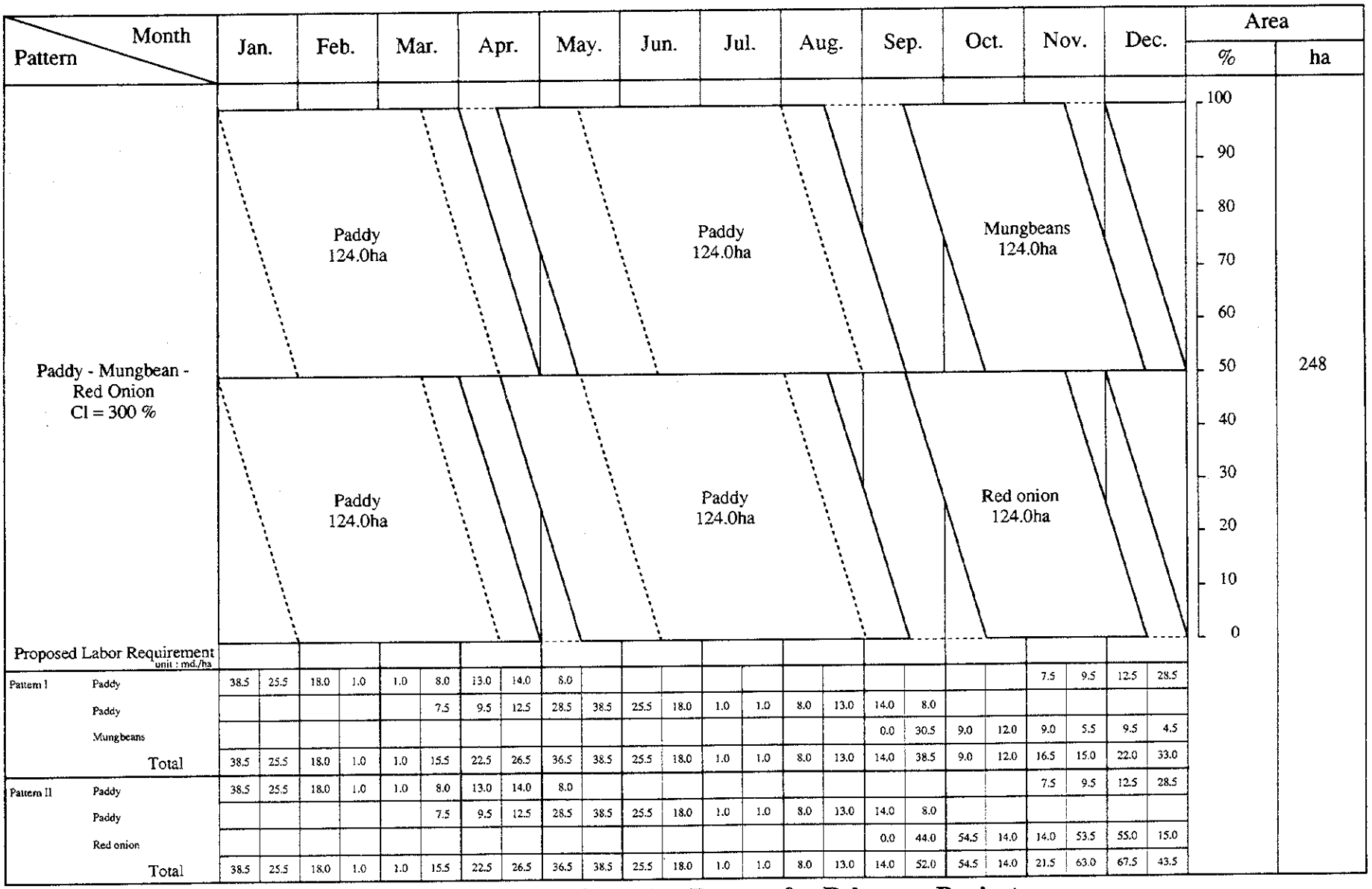


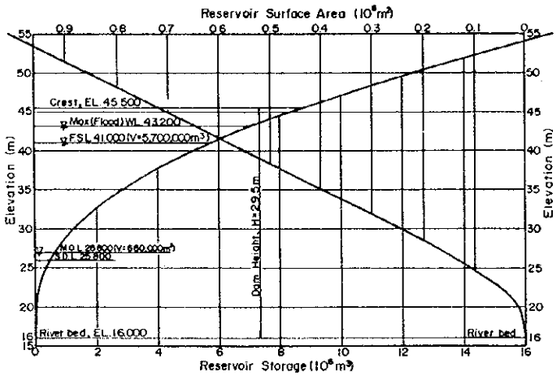
Figure 4.2 Result of Reservoir Operation in Pelangan Embung



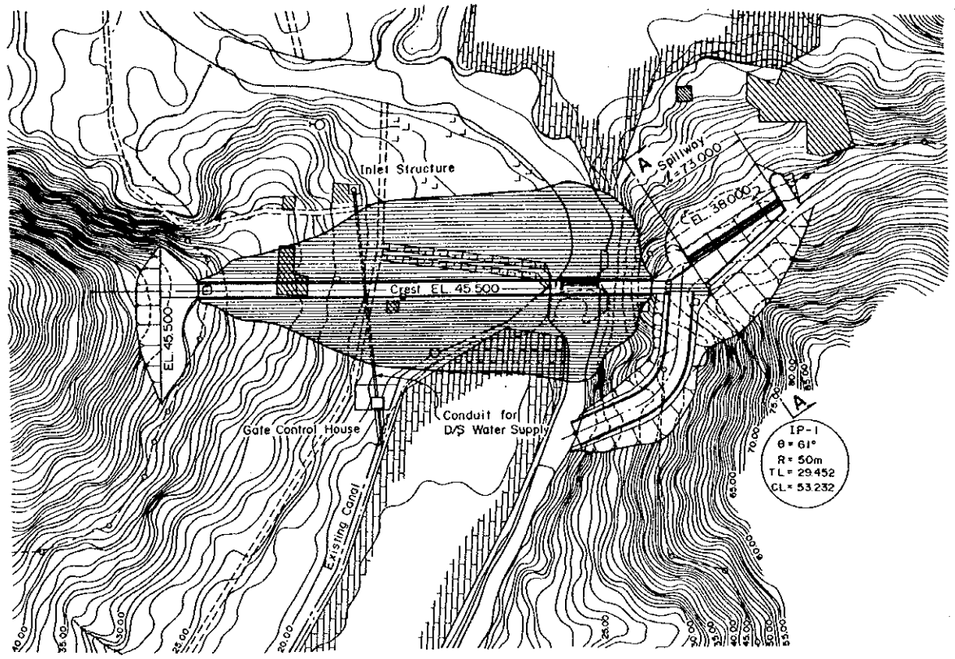
Proposed Labor Requirement
unit : md./ha

Pattern I	Paddy	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0												7.5	9.5	12.5	28.5
	Paddy						7.5	9.5	12.5	28.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0						
	Mungbeans																	0.0	30.5	9.0	12.0	9.0	5.5	9.5	4.5
	Total	38.5	25.5	18.0	1.0	1.0	15.5	22.5	26.5	36.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	38.5	9.0	12.0	16.5	15.0	22.0	33.0
Pattern II	Paddy	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0												7.5	9.5	12.5	28.5
	Paddy						7.5	9.5	12.5	28.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0						
	Red onion																	0.0	44.0	54.5	14.0	14.0	53.5	55.0	15.0
	Total	38.5	25.5	18.0	1.0	1.0	15.5	22.5	26.5	36.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	52.0	54.5	14.0	21.5	63.0	67.5	43.5

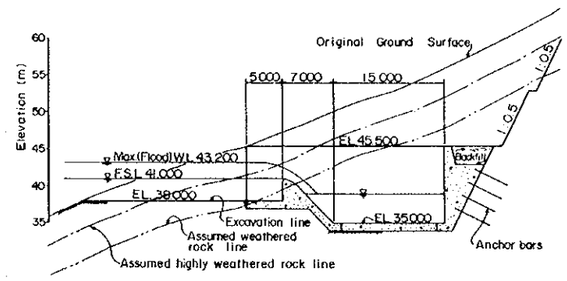
Figure 4.3 Proposed Cropping Pattern for Pelangan Project



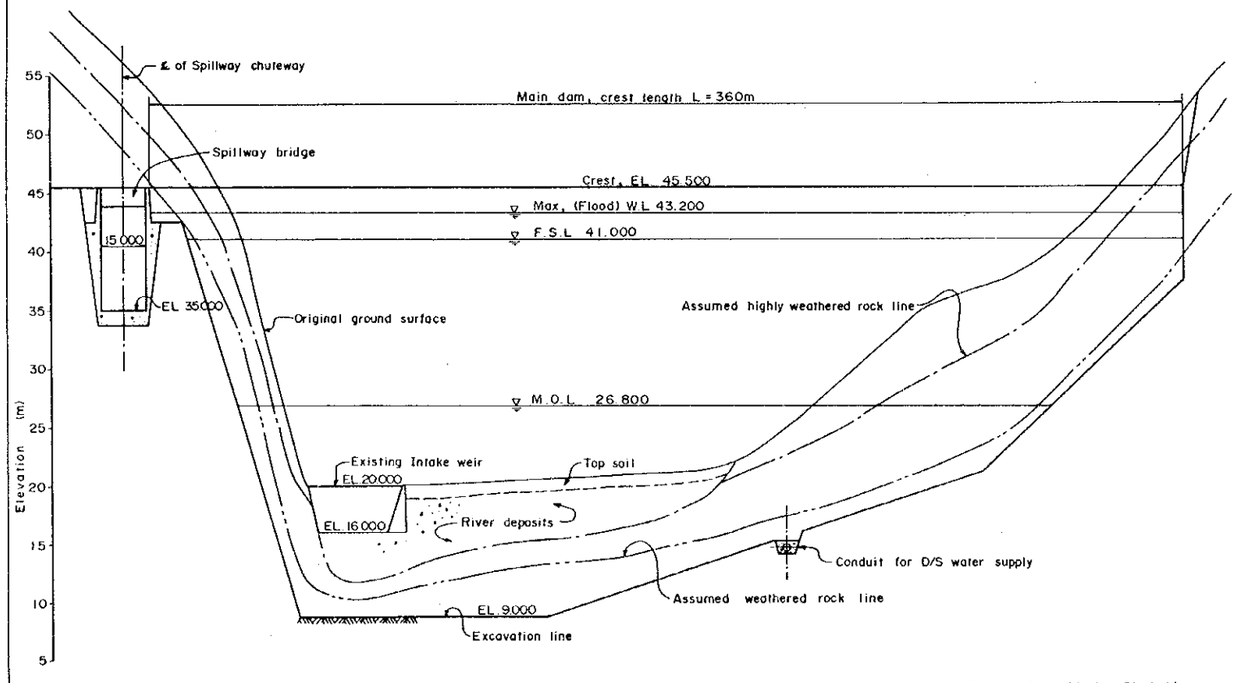
RESERVOIR STORAGE CURVE AT PELANGAN



PLAN Scale A



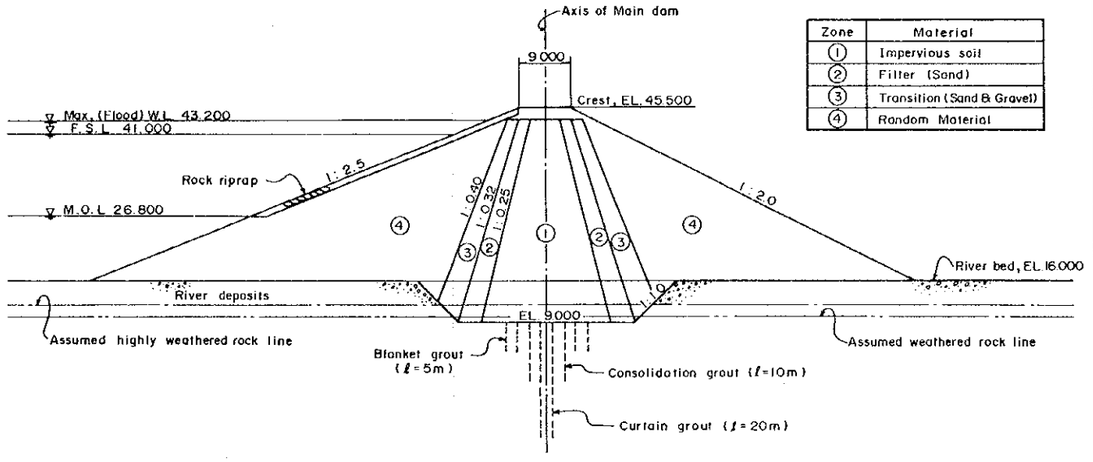
SECTION A-A
Scale C



PROFILE OF MAIN DAM

Scale : H = 1 : 1.000
V = 1 : 250

Note : Grouts (Curtain, Consolidation, Blanket) are not shown.



Zone	Material
①	Impervious soil
②	Filter (Sand)
③	Transition (Sand & Gravel)
④	Random Material

MAXIMUM CROSS SECTION OF MAIN DAM

Scale B

Scale A 0 50 100 150 200m

Scale B 0 10 20 30 40 50m

Scale C 0 10 20 30 40m

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

GENERAL PLAN OF PELANGAN EMBUNG

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.4 General Plan of Pelangan Embung

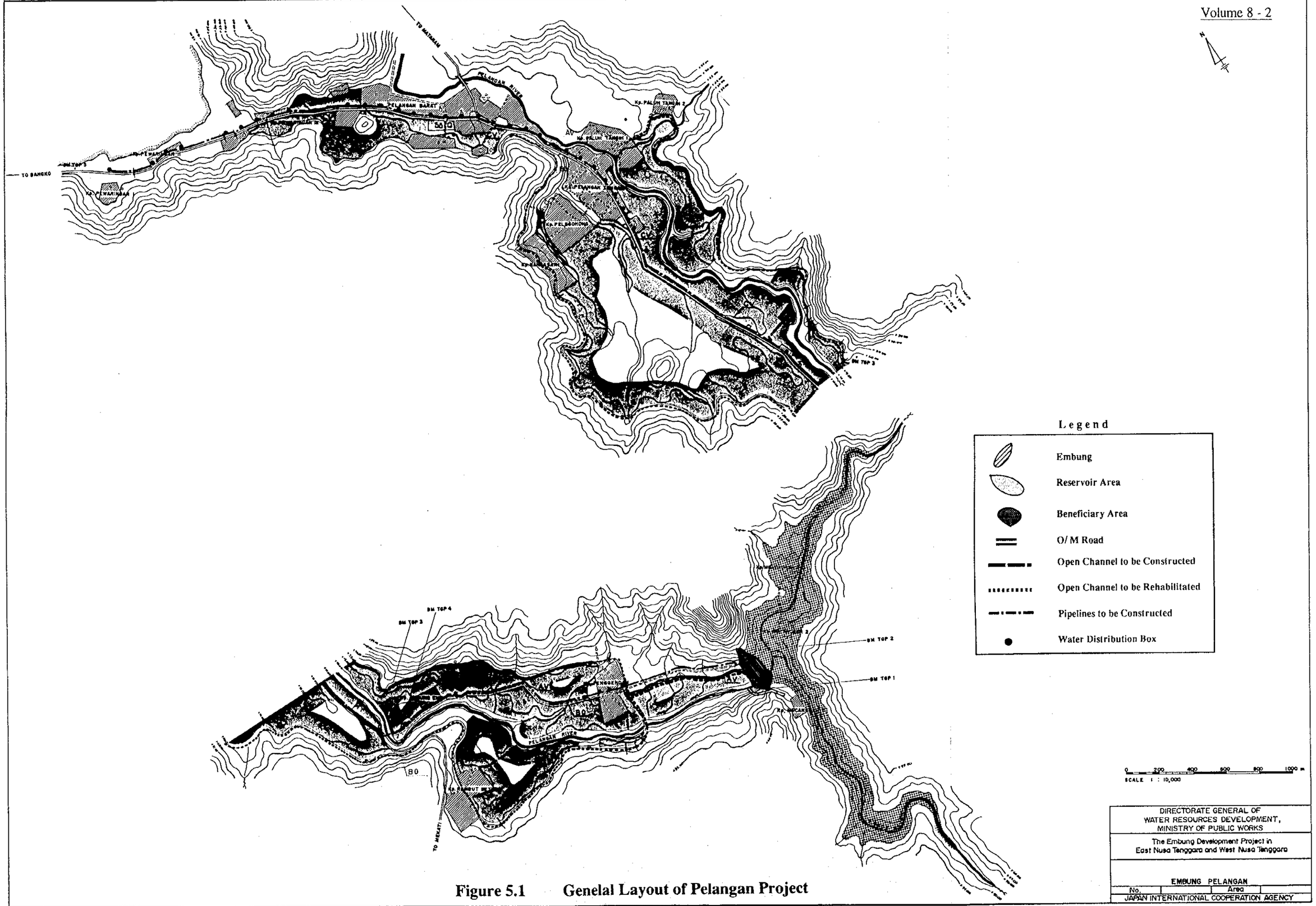


Figure 5.1 Genelal Layout of Pelangan Project

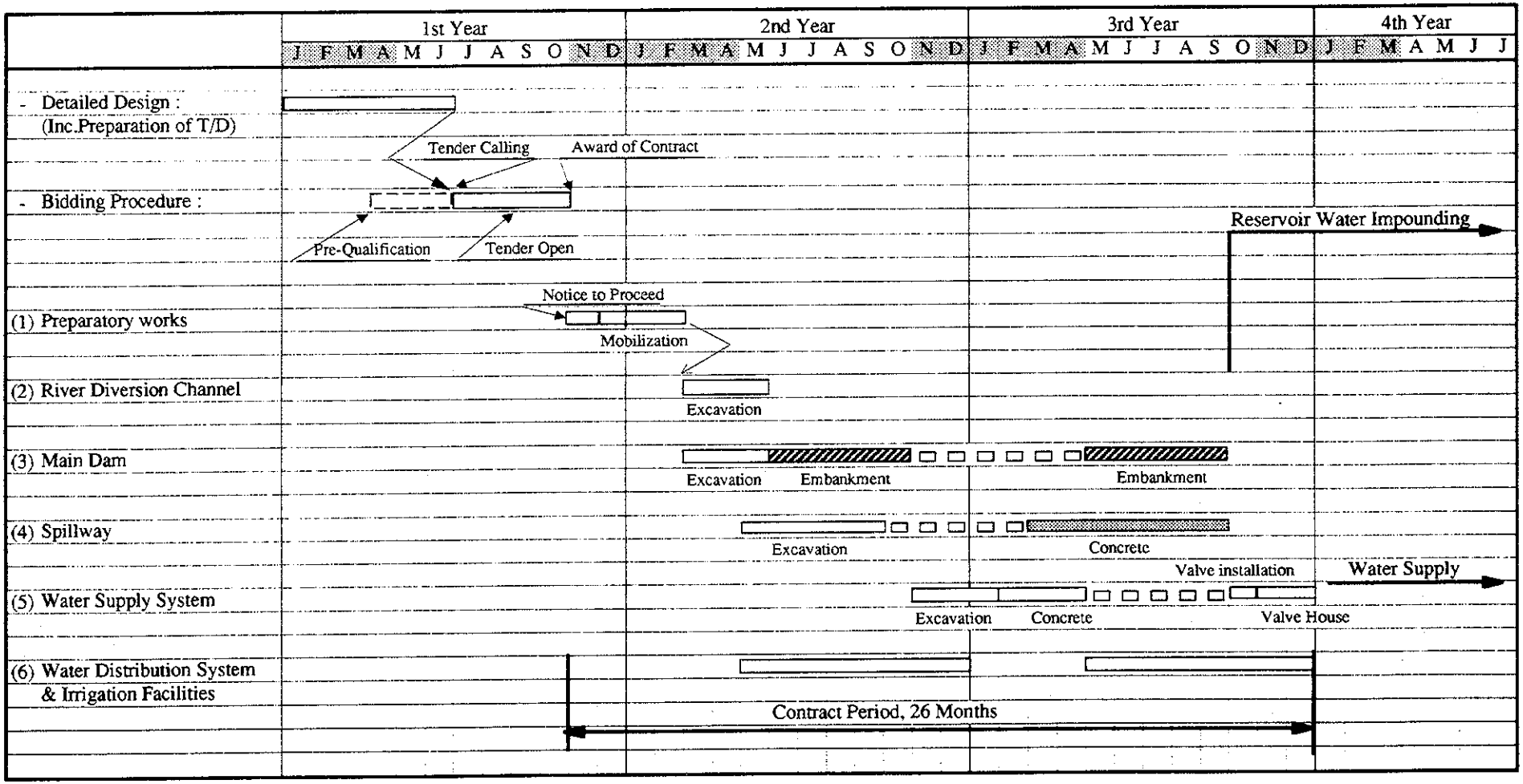


Figure 6.1 Construction Time Schedule for Pelangan Project

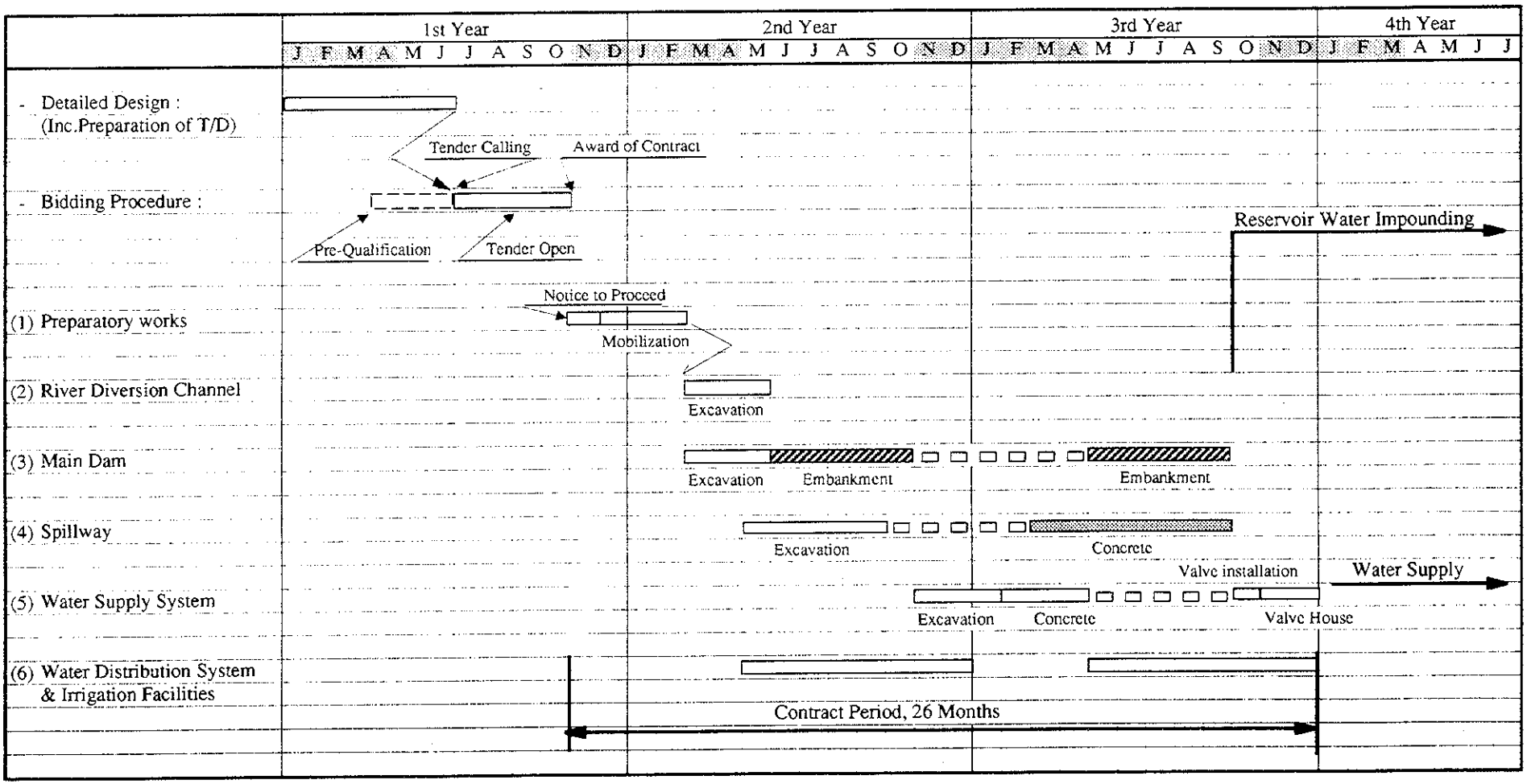


Figure 6.1 Construction Time Schedule for Pelangan Project

Japan International
Cooperation Agency
(JICA)

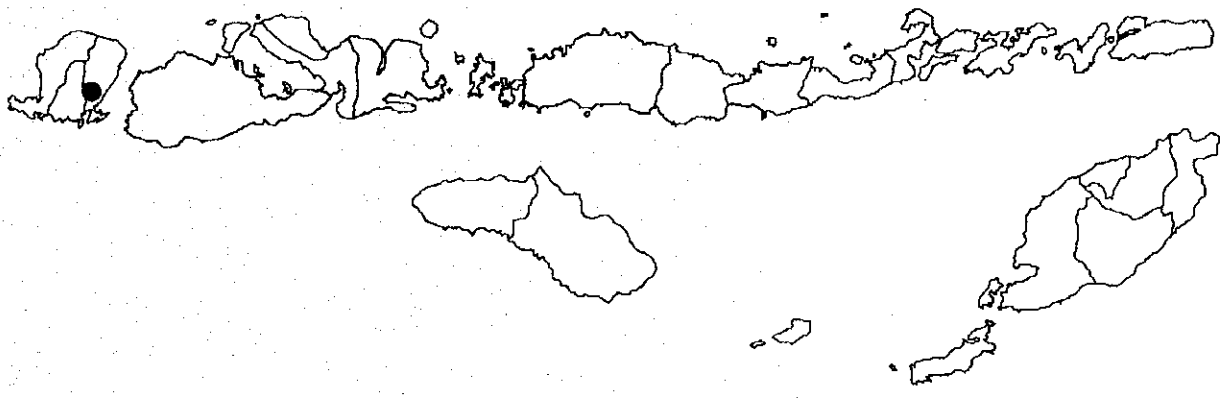
Directorate General of
Water Resources Development,
Ministry of Public Works

The Study
on
The Embung Development Project
(Small Scale Imponding Pond Development Project)
in
East Nusa Tenggara and West Nusa Tenggara
in
The Republic of Indonesia

Final Report

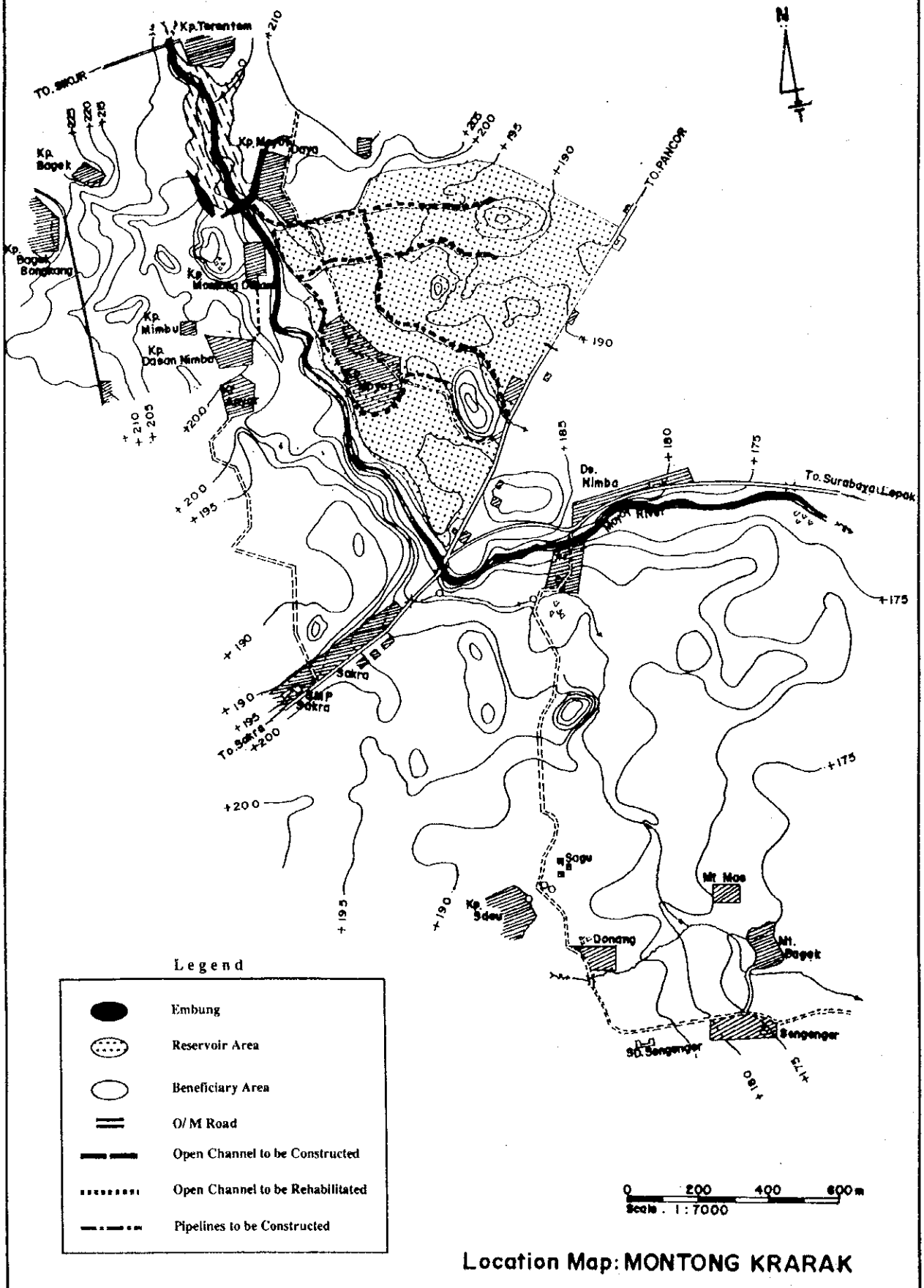
Voleme 8-3

Feasibility Study
on
Montong Krarak Embung Development Project



May 1995

Nippon Koei Co., Ltd.



Location Map: MONTONG KRARAK

THE STUDY
ON
THE EMBUNG DEVELOPMENT PROJECT
(SMALL SCALE IMPOUNDING POND DEVELOPMENT PROJECT)
IN
EAST NUSA TENGGARA AND WEST NUSA TENGGARA
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME 8-3

FEASIBILITY STUDY
ON
MONTONG KRARAK EMBUNG DEVELOPMENT PROJECT

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1. PRESENT SITUATION OF THE PROJECT AREA

1.1 Location and Topography

The Project area is located in Moyotdaya Village of Kecamatan Sikur, Kabupaten Lombok Timur. The proposed Embung site is located on the Montong Krarak river, which is about 50 km from Mataram, the capital of Nusa Tenggara Barat (NTB) Province.

Topographical condition of the catchment area shows gentle slope with highly developed agricultural land. There are rather small hills with gentle slope, creating the boundary of river basin. Beneficiary area is located along the both sides of the Montong Krarak river, which extends about 2 km downstream from the proposed Embung site.

Major residential zone of the Project area consists of Karanganyar, Moyot and Montong Krarak Villages in the downstream and Moyotdaya and Terentem Villages in the upstream area.

1.2 Climate and Hydrology

The nearest climate and rainfall stations from the proposed Embung site are Selong and Pegondang/Sakra, respectively. The wet season usually starts from November and ends March in the Project area with the average annual rainfall of 1,200 mm. Mean annual temperature is 27.7 °C with the average maximum temperature of 32.9 °C and the average minimum temperature of 22.5 °C. Mean relative humidity is 80.0%. Average sunshine hours are 6 to 7 hr/day during the wet season and increase to 8 to 9 hr/day in the dry season. Winds are stronger from June to September and weaker from December to March with the average wind velocity of 3.8 km/hr. Tables 1.1 and 1.2 show monthly rainfall record at the Pegondang/Sakra station and climate data at the Selong station, respectively.

The Kali Moyot river drains the south side of Mt. Rinjani. The river rises near Sikur where the altitude is approximately 300 m and follows a southeasterly course. It discharges into the Alas Strait. The surface of the catchment area is mostly covered with paddy field and households. The catchment area at the proposed Embung site is 5.4 km ^{2}. There is no gauging station on this river.

1.3 Geology

The proposed Embung site is mainly underlain by volcanic products of Mt. Rinjani of the Quaternary age. This volcanic products are half consolidated rock and not homogeneous, named the Kalibabak Formation of Pliocene to Pleistocene age. The geological formation is: andesitic breccia composed of andesitic breccia which is mainly andesite with tuff, soft rock belonged to the Kalibabak Formation; terrace deposits composed of mainly sand and gravel forming terrace with flat to gentle slope; alluvium composed of sand, silt and gravel forming lowland; detritus composed of soil with rock fragments and distributed at foot of slope or gentle valley; and, river deposits composed of sand, silt, gravel and boulder, and distributed along the existing river bed.

1.4 Soils and Land Use

The Project area of Montong Krarak extends on the undulating plain along the Moyot river. The land slope of the farmland is 2 to 3% on an average. There exist many mounds with an area of 1 to 2 ha on the plain.

Parent material of the soils is basaltic rock or alluvial materials. Soil drainage on farmland is moderately well and soil permeability is moderate to very slow. Soil depth is deep to very deep ranging from 60 cm to more than 110 cm. Soil texture of surface soil is sandy clay to clay.

The results of the soil survey are shown in Table 1.3 on a typical soil profile out of 10 soil test pits, Table 1.4 on soil laboratory tests out of three pits out of 10 pits and Table 1.5 on the soil classification.

All land of the Project area have been developed as wet paddy field except coconut field of 5 ha and bush/scrub of 39 ha on the Moyot river escarpment and mounds.

The wet paddy field covers 227 ha or about 80% of the Project area. The eastern part of paddy field of 153 ha is irrigated by the three existing intake weirs and canal network. The density of irrigation canals is higher in the upstream irrigation area of 49 ha, while it is lower in the downstream irrigation field of 104 ha. The remaining 74 ha of the paddy field are under the rainfed condition.

The present land use is classified on the 1/5,000 topographic map and summarized below.

Present Land Use on the Project Area of Montong Krarak

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	153	74		227
Upland	0	0		0
Tree crops	0	5		5
Bush/Scrub/Grassland			39	39
Residential			14	14
Cemetery			1	1
Others			0	0
Total	153	79	54	286

Source : The JICA Study Team

The present land use and soil classification of the Project area is illustrated in Figure 1.1.

1.5 Demography

The demographic condition in the Project area as of 1993 is indicated by a total population of 3,977 and a total number of households of 818 including 647 farm households as shown below. The average family size is 4.9 persons. Ethnic condition is multiracial and the majority of inhabitants embrace Islam religion. Their education attainment is commonly primary school grade.

Present Demographic Condition

Village	Sub-Village	Total Population (person)	Total Household (No.)	Family Size (person)	Farm Household (No.)
Sakra	Montong Krarak	462	84	5.5	63
	Baru	903	154	5.9	121
	Kw. Berora	584	92	6.3	73
Rumbuk	Kw. Direk	802	177	4.5	164
	Moyot	1,226	311	3.9	226
Total		3,977	818	4.9	647

Source : JICA Water Use Survey

1.6 Domestic Water Use

Available water source facilities for domestic water use in the Project area are 165 small dug wells, five springs and three public water basins, while livestock water source depends on the Moyot river. No inhabitants are confronted with water shortage in getting their drinking water but all breeding families are facing insufficient livestock water supply from June to December. The present water use in each sub village clarified under the Study is summarized below:

- In Montong Krarak Sub-Village, 50 households depend their drinking water sources on a dug well at the average distance of 150 m and the rest are using three springs 250 m away from their houses;
- In Baru Sub-Village, 150 families get their drinking water from 40 small dug wells at the average distance of 50 m and another four households are users of a public water basin nearby their houses;
- In Kw. Berora Sub-Village, 76 families are using 63 small dug wells 50 m away and nine households depend on a public water basin nearby their houses, while seven families are users of the both water source facilities;
- In Kw. Direk Sub-Village, 156 families depend on 28 small dug wells 75 m away and 15 households are using a public water basin nearby their houses, while six families are users of the both water source facilities; and
- In Moyot Sub-Village, 237 households get their drinking water from 33 small dug wells at the average distance of 50 m and the remaining 74 families carry their drinking water from two springs 200 m away.

1.7 Social Infrastructures

The access from Mataram to the Project area is the Mataram-Labuhan Lombok road which is a two-lane paved road. The proposed Embung site is linked by a branch road connecting this main route with Sakra town and an earth road from Sakra. The on-going rural electrification network project is planned to be extended to the Project area soon.

Inhabitants are generally using the Moyot river bed for defecating purposes. There are an auxiliary hospital and an integrated health service center within the Project area.

1.8 Agriculture and Livestock

(1) Present cropping pattern and intensity

The average annual planted areas of major crops are summarized below.

Present Cropping Pattern and Intensity

Cropping Pattern	Net Area (ha)	Planted Area (ha)	Proportion of Planted Area (%)	Cropping Intensity (%)
(1) Paddy - Palawija	107.0	129.0	67.3	129
(2) Paddy - Fallow	67.0	67.0	32.7	100
Total / Average	174.0	205.0	100.0	120

Source : The JICA Land Use Survey and Inventory Survey

(2) Farming practice and farm inputs

Wet paddy is cultivated in the irrigated area during the wet season, while Palawija crops are cultivated partly during the dry season. Major Palawija crops are tobacco and groundnut. On the rainfed paddy field, single cropping of the dry season paddy is generally practiced.

With regard to paddy, most farmers conduct land preparation with an animal-drawn plough and harrow their wet paddy field once or twice every season, while the other marginal farmers depend on their own man-power. High yielding rice varieties such as IR36, IR64, Krueng Aceh, Pelita and C4 are grown. Rice seed is sown on a nursery bed which is in the ratio of one twentieth against the main paddy field. Manual weeding is usually done one to three times during the rice growing period. Harvesting is carried out by using a sickle and hand threshing is conducted by beating rice plants against a frame.

Predominant cultivation methods for Palawija crops are very primitive and local varieties are commonly used. Land preparation, planting, weeding and harvesting are done by hand.

Farm inputs and labor requirements presently used for growing these crops are given below.

Present Farm Inputs and Labor Requirements

Description	Unit	Wet Paddy	Groundnut	Tobacco
Farm Inputs				
Seed	kg/ha	50	60	0.1
Fertilizer				
Urea	kg/ha	300	50	250
TPS	kg/ha	100	100	200
KCl	kg/ha	50	25	100
Agro-chemicals	lit/ha	-	-	-
Labor Requirements				
Nursery	md/ha	3	-	-
Land preparation	md/ha	2	10	10
	ad/ha	5	-	-
Planting	md/ha	3	4	2
Transplanting	md/ha	15	-	5
Weeding	md/ha	10	4	8
Pest & disease control	md/ha	2	2	4
Farm management	md/ha	2	2	2
Harvesting	md/ha	15	10	5
Transportation	md/ha	5	5	5
Others	md/ha	4	2	2
Total	md/ha	61	39	43
	ad/ha	5	-	-

Source : The JICA Farm Economy Survey

(3) Crop yield and production

The present crop yield and production in the Project area are estimated as shown below. Unit yield of major crops remains extremely low due to shortage of irrigation water, insufficient farm input supply and traditional farming practices.

Present Crop Yield and Production

Crops	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)
Wet Paddy Field			
Irrigated			
Wet season paddy	138	3.00	414
Rainfed			
Wet season paddy	67	2.00	134
Dry season Palawija			
Tobacco	30	1.20	36
Groundnut	10	0.60	6
Upland Field			
Groundnut	40	1.20	48

Source: The JICA Inventory Survey

(4) Livestock population

Various kinds of livestock are raised in the Project area and their population is given below. Cows and buffaloes play important roles in land preparation works as draft power. Other livestock are raised for self-consumption purpose.

Current Population of Livestock

Unit: head

Breeding Household	Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
138	147	96	9	54	0	286

Source: The JICA Water Use Survey

1.9 Irrigation Facilities

In the Project area, there exists paddy field of 49 ha in gross on the left bank of Moyot river. The paddy field has been irrigated by the existing two weirs. One is situated at around 300 m upstream of the proposed Embung site (People weir) and the other is situated at the proposed Embung site (Kwang Direk weir). These weirs are functioning rather well. Irrigation water taken by the People weir is led by the existing canal to the irrigation area with a distance of about 1.0 km. This canal is earth-lined and not functioning well. Irrigation water taken by the Kwang Direk weir is led by the existing canal to the irrigation area with a distance of about 1.0 km. This canal is lined by the stone masonry and is not functioning well. Due to the shortage of river flow and poor conditions of the existing facilities, the wet paddy field in the Project area has been irrigated only for the wet season under the unstable condition.

1.10 Agro-economy

(1) Farmers group

Farmers are members of Agricultural Cooperative (KUD). From its branch shop, they commonly purchase fertilizers and use credit services. They are also members of Village Youth Association. Around 50% of farmers benefited by the existing irrigation scheme established Water Users' Association (P3A/HIPPA) in 1994 and started to operate it for the purpose of maintaining on-farm irrigation service facilities and managing irrigation water distribution.

(2) Agricultural supporting services

Agricultural extension services are provided to farmers by field extension workers (PPL) attached to a rural extension center (BPP) in Sakra. Usually, farmers receive PPL's visiting service very few because of limited budget for field operation in BPP. Some PPLs are livestock specialists to provide various services under the instructions of a specialized agricultural extension agent assigned to a district center for agricultural extension. Veterinary care services are given to breeding households through an animal health center of the Veterinary Service of the Department of Livestock. The present level of livestock extension services is similar to that of the agricultural extension services.

Credit services are available in KUD as well as in the service network of the Indonesian People's Bank (Bank Rakyat Indonesia) both handling "Credit for Farmer (KUT)" and "Income Generating Project for Marginal and Landless Farmers (P4K)". Financial sources of these credits are the Government for KUT and IFAD for P4K aiming at group financing.

Lombok Water Resources Development and Conservation Project Office (Proyek PKSA Lombok) under the NTB Provincial Public Works Service (DPUP) is responsible for new water resource development and watershed management. New development of irrigation system is the responsibility of Lombok Irrigation Project Office, while upgrading and rehabilitation works are the main task of Provincial Project Office for Rehabilitation and Upgrading of Irrigation. Operation and maintenance works of all facilities are conducted by Provincial Project Office for Operation and Maintenance (PPO&M APBD). These project offices are under the direction of DPUP.

(3) Farmers' household economy

The results of agro-economy survey carried out in the Project area under the Study reveal that the average income and expenditure of 15 sample farmers amount to Rp. 1.57 million and Rp. 3.23 million, respectively. Sample farmers make up for deficit in their household economy by selling their livestock. Table 1.6 shows the summary of replies of 15 respondents.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs and Constraints

(1) Population increase

The future population in the Project area is anticipated by referring to "Projection of Population for Kabupaten/Kotamadya in Indonesia 1990-2000" prepared by National Statistic Bureau and the Second Long Term Development Plan (PJPT II). The total number of inhabitants living in the Project area will increase from 3,977 persons as at 1993 to 4,191 persons in 1998, 4,396 persons in 2003, 4,584 persons in 2008, 4,794 persons in 2013 and 4,898 persons in 2018.

(2) Basic human needs (BHN)

The inhabitants in the Project area are satisfied with the present condition of rural infrastructures because they have many small dug wells as drinking and livestock water source facilities and will receive rural electricity distribution service soon. The pressing need is however to enhance drinking water source other than available wells because the quality of shallow well water is not so good.

(3) Economic development needs

All of 647 farm households have principally consumed their farm products for their own use and then sold the remaining amount to local markets. There is not much possibilities of developing manufacturing and service sector industries in and around the Project area so as to offer new job opportunities to farmers. It is therefore indispensable for promoting public investment to economic infrastructures, especially for irrigation water source facilities, which encourage farmers to improve their farming system and enable them to increase their agricultural production. Increasing farm outputs could clue farmers themselves to upgrade their living standard and to catch up with faster economic growth of other sectors and places.

(4) Inhabitants' intention to development pattern

Inhabitants in the Project area intend to use their farm land more intensive because no expansion of land holding size can be expected. To do so, they need all year-round water source facilities from which they will be able to get sufficient irrigation water for growing the dry season crops. They also intend to get more clean water for drinking purpose. Another remarkable point of their intention is that nobody wants to cooperate in land acquisition for public works because of their small land holding size.

(5) Development constraints

The present constraints against social upgrade and economic development in the Project area are featured by the condition that many inhabitants depend their irrigation water sources on the Kali Moyot river even though its river basin is small. There are nine intake weirs already constructed on the river for diverting surface discharge to irrigate wet paddy field. Due to such full utilization of the river flow, the Kali Moyot river has no more water resources unless countermeasures to regulate the wet season runoff are practiced. As a result, this limitation of water resources has acted as the barrier to promote intensive agricultural development. Further, low quality of dug well water has adversely affected improvement of inhabitants' living circumstances.

2.2 Development Concepts and Approach

(1) Development concepts

The existing gap of economic status between NTB and other Provinces is caused by insufficient fulfillment of BHN, slow pace of poverty alleviation and less concerns about a balanced investment to regional development. In harmony with the national policy to correct this economic imbalance, the development concept is formed aiming at improvement of social and economic infrastructures with the highest priority so as to meet BHN and increase agricultural outputs. Among others in the Project area, it is prerequisite to pay special attention to how to solve irrigation water shortage problem caused by full use of the Kali Moyot river flow and also low quality of drinking water.

(2) Development strategies and approach

To overcome development constraints prevailing in the Project area, water resources seasonally available are to be regulated by means of constructing Embung as water reservoir on the Kali Moyot river. Approach to development planning of the potential Embung is as follows:

- To put the first priority to supply irrigation water and the second to domestic water taking into account inhabitants' needs and intention;
- To project the future water demand for irrigation and domestic use at the target year of 2008 being the last year of Pelita VIII;
- To examine development potential of the Montong Krarak Embung from the technical viewpoints including assessment of custom of water use coupled with the designed intake capacities of the existing weirs;
- To determine the optimum development scale of the Embung;
- To make preliminary design and cost estimate; and
- To conduct investment justification from the viewpoints of economic soundness, social satisfaction and environmental impact.

2.3 Land Potential

All of the available land, which are suitable for agricultural use from the topographical condition, are already converted to wet paddy field with or without irrigation facility. Therefore, no land transformation to wet paddy field is expected in the future land use in this area.

As for irrigation area, the wet paddy field on the left bank is fully irrigated already. Because the rainfed paddy field on the right bank has relatively high elevation, the expandable area for irrigation water supply is estimated as less than 10 ha. The installation of irrigation canal on the right bank can be considered to be not viable by the above reason. The expected irrigation area is still 153 ha, of which 49 ha could be stably irrigated by constructing the proposed Embung.

In conclusion, the future land use plan of the Project area is offered as shown below.

Future Land Use Plan on the Project Area of Montong Krarak

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	153	74		227
Upland	0	0		0
Tree crops	0	5		5
Bush/Scrub/Grassland			39	39
Residential			14	14
Cemetery			1	1
Others			0	0
Total	153	79	54	286

Source : The JICA Study Team

The impounding area of the proposed Embung is quite small as much as 2 ha in total. This area is mostly river surroundings partly used as paddy field. The area of the impounding paddy filed is so small that the land compensation may not require a large amount.

2.4 Agricultural and Livestock Development Plan

(1) Alternative cropping patterns

In formulating the future cropping patterns in the Project area, the following basic principles have been adopted:

- Higher benefit for farmers;
- Optimum use of irrigation water;
- Practical farming system for family labor; and,
- Crops and cropping patterns acceptable to farmers.

Wet paddy is the most predominant crop in the Project area and acceptable to farmers as they have long experience in rice cultivation. Therefore, they could easily master irrigated rice cultivation method to realize higher production and thereby large irrigation benefit under the condition of "With Project". Aiming to determine the optimum development scale of the proposed Embung, the following alternative cropping pattern is established.

Alternative Cropping Patterns

Pattern Code	Wet season		Dry season			
			First cropping		Second Cropping	
	Crop	Coverage (%)	Crop	Coverage (%)	Crop	Coverage (%)
With Project B-21	Paddy	100	Soybean	50	-	-
			Tobacco	50	-	-

(2) Farm input and labor requirements

Under the "With Project" condition, farmers who are depending on unreliable rainfall, river flow or irrigation water can be expected to get stable irrigation water supply. They will be able to increase farm inputs to the optimal level with less risk. Proposed farm inputs are estimated in consideration of the present input level in advanced irrigation areas as well as data collected from BPP. Labor requirements are also expected to increase substantially in cultivation under the technical irrigation system. On the other hand, farm input and labor

requirements are expected to remain at the present level under the "Without Project" condition.

Proposed Farm Input and Labor Requirements

Item	Unit	Wet Paddy	Soybean	Tobacco
Farm Inputs				
Seed	kg/ha	25	40	0.1
Fertilizer				
Urea	kg/ha	300	50	100
TPS	kg/ha	100	100	100
KCl	kg/ha	50	50	50
Agro-chemicals	lit/ha	2	2	1
Rodenticide	kg/ha	2	1	-
Labor	md/ha	185	70	200
Draft Animal	ad/ha	20	10	10

(3) Proposed farming practices

Proposed farming practices for wet paddy are as follows:

- High yielding rice varieties to be used under the With Project condition are IR64, Krueng Aceh, Pelita, C4 and IR36 with maturing periods of 110 to 135 days. These varieties are moderately resistant or resistant to several major rice pests and diseases. Land preparation on wet paddy field has to be done by animal ploughing and harrowing;

- Fertilizers need to be applied three times; the first application at the final stage of land preparation, and the second and third application as top-dressing at the 20th and 37th day after transplanting, respectively. The top-dressing will be applied while water depth on wet paddy field is shallow. The phosphorous (TPS) and potassium (KCl) fertilizers have to be applied at the final stage of land preparation. The required amount of fertilizers is 60 kg/ha of N, 30 kg/ha of P and 30 kg/ha of K;

- Seed rates are 20 to 40 kg/ha for nursery. The best period for transplanting is 3 to 4 weeks after sowing, when the seedlings have 5 to 6 leaves. Ratio of the nursery bed to the main wet paddy field is about one twentieth. Planting density is about 2 to 3 plants per hill and spacing of hill is 20 cm x 20 cm;

- Weeding is required to be performed two to three times during the rice growing period according to weed growth. Irrigation water supply needs to be guaranteed during the most critical stages of the plant growth such as tillering, booting, flowering and germination stages. Timely control of insects, pest and diseases is necessitated on the basis of advice by PPLs and their assistants; and

- It is desirable to carry out harvesting when the ears are nearly ripened and are still in slight green. Harvesting is made by labors using a sickle. Harvested paddy plants need to be dried on the field for 3 to 4 days.

For growing Palawija crops under the irrigated condition, advanced farming practices similar to irrigated wet paddy cultivation and high yielding varieties are to be adopted. Land preparation will require animal-draft in order to enhance efficiency and accuracy of the work. Proper fertilization matching with soil conditions and timely insect/disease control are also indispensable. These farming practices need to be applied for, following technical instructions of PPLs.

(4) Anticipated crop yield

It is anticipated that the future yield of proposed crops under the "With Project" condition increases to 4.5 ton/ha for wet paddy, 1.4 ton/ha for soybean and 2.0 ton/ha for tobacco. These targets are estimated in due consideration of the present yield level in well established irrigation areas of Kabupaten Lombok Tengah as well as introduction of high yielding varieties and advanced farming practices, stable irrigation water supply and optimum use of farm inputs. As for build-up period to attain the anticipated yield, it is also prospected that crop yield level is 60% of the target in the first year, 70% in the second year, 80% in the third year, 90% in the fourth year and 100% from the fifth year and onward.

(5) Projected livestock population

The future livestock population in the Project area for the target year 2008/2009 is projected as shown below taking into account the actual growth rate of each livestock in Kabupaten Lombok Tengah during the Pelita V period.

Projected Population of Livestock

Unit: head

Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
189	120	48	48	0	1,627

2.5 Water Demand

(1) Domestic water demand

The future domestic water consumption level in rural areas of NTB is set to be 60 lit/day/capita up to 1998/99 for the Pelita VI period, 70 lit/day/capita up to 2003/04 for the Pelita VII period and 80 lit/day/capita from 2004/05 and onward. The public water demand is to be 30 lit/day for 10% of the projected population, while the unaccounted-for is to be equivalent to 25% of the total water demand.

Following the projected population, the future domestic water demand is estimated as shown below. The annual domestic water demand for 2008 is projected to be 166,700 m^3.

Projected Domestic Water Demand

Item	Unit	1998	2003	2008	2013	2018
Population	person	4,191	4,396	4,584	4,749	4,898
Domestic water	'000m^3/yr.	91.8	112.3	133.9	138.7	143.0
Public water	'000m^3/yr.	4.6	4.8	5.0	5.2	5.4
Un-accounted for	'000m^3/yr.	19.3	23.4	27.8	28.8	29.7
Total demand	'000m^3/yr.	115.7	140.5	166.7	172.7	178.1

(2) Irrigation water demand

In order to optimize the development scale and delineate the beneficiary area of the Project, irrigation water demand for each proposed crop is estimated for unit irrigation area of 1 ha on the semi-monthly base taking into account crop consumptive use, evapotranspiration, crop coefficient, effective rainfall and irrigation efficiency both for wet paddy and Palawija crops as well as land preparation water, layer replacement and percolation loss only for wet paddy. As described in Attachment 1, irrigation water demand in the Project area is calculated by referring to the standard quoted in "Irrigation Design Standard, KP-01" by DGWRD.

Tables 2.1 and 2.2 show the calculation results of evapotranspiration and effective rainfall, respectively, and Table 2.3 presents the unit irrigation water demands for each crop.

3. EXAMINATION OF EMBUNG DEVELOPMENT POTENTIAL

3.1 Topographic Condition

The Montong Krarak Embung site was identified by PRIS of NTB through its identification study in 1993. Under the present Study, the possibility of developing this Embung is firstly confirmed through the inventory survey. Then topographical survey with mapping and geological investigations are carried out at the proposed Embung site, reservoir area and beneficiary area. At the dam site confirmed, there is a small irrigation intake weir. The both sides of abutment show small V-shaped valley with about 200 m in width at El. 210 m and the river bed shows El. 195.0 m.

3.2 Geological Condition

The proposed Embung site is underlain by volcanic breccia of the Quaternary age. The foundation is mainly formed of volcanic breccia. The drilling survey shows that volcanic breccia is semi-consolidated and its coefficient of permeability varies from 3.9×10^{-5} to 2.2×10^{-6} cm/sec. Ground water is present only at near the river bed.

The reservoir area is mainly underlain by volcanic breccia. No major fault and landslide are recognized in the reservoir area. No major problem for water leakage is assumed to occur in the reservoir area. Geological map and profile are shown in Figures 3.1 and 3.2.

3.3 Availability of Embankment Materials

The sound rock foundation of and the availability of embank materials around the proposed Embung site are suitable for applying a stone masonry type for the main dam and a homogeneous earthfill type for the saddle dam located on the right abutment of main dam.

The quarry sites for the stone masonry and the borrow area for the saddle dam are investigated from the technical and economical viewpoints. The following shows the summary of the materials available in respective locations.

Availability of Construction Materials

Material	Location	Description
I. Main dam (Stone Masonry Dam)		
1. Coarse aggregate	(1)Meringgik river	Boulder & gravel of river deposits
	(2)Mountain on right-side of the dam site	Crushed stone from Tuff breccia/ Andestic breccia
2. Fine aggregate	(1)Montong Krarak river (2)Kermit/ Meringgik river	sand from the river deposits
II. Saddle dam (Homogeneous earthfill dam)		
1. Impervious soil	Reservoir area	Silty sand on river course and sandy clay in paddy & arable lands
2. Filter materials	Kermit/ Meringgik rivers	sand & gravel of the river deposits

3.4 Availability of Water Resources

(1) Catchment yield

As for the Moyot river, there is no record of discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. The Pegondang/Sakra rainfall station which is located in the south of the Montong Krarak Embung catchment has rainfall record of nearly consecutive 36 years and is considered to represent catchment rainfall. The generated catchment rainfall is given in Table 3.1. A runoff coefficient of 0.35 is adopted considering the characteristics of the catchment area and the previous hydrological analysis in the Lombok Island. Using this runoff coefficient and rainfall record at Pegondang/Sakra, river flow of the Moyot at proposed Embung site is estimated.

The following conditions are considered for estimation of the half monthly discharge:

- Catchment area of the proposed Embung site is 5.4 km^2; and,
- Less than 20 mm of half monthly rainfall is ignored for estimation.

This estimation is made based on the rainfall record from 1960 to 1985. The estimated half monthly discharge is given in Table 3.2 and monthly discharge is summarized below.

Mean Monthly Discharge

Unit: 1,000 m^3

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
508	422	289	88	95	50	44	4	17	87	262	409	2,273

(2) Floods

The flood analysis is made to determine the design discharge of the structures, such as spillway, diversion tunnel, and so on. Taking availability of the flood record and size of the catchment area into account, the rational formula is adopted to estimate the flood discharge in the Study. The formula is;

$$Q = 0.2778\ f\ r\ A$$

where, Q : Peak discharge (m^3/s)
f : Runoff coefficient
r : Average rainfall intensity within time of concentration (mm/hr)
A : Catchment area (km)

1) Design rainfall

Design rainfall is estimated by the Log Pearson Type III method, which is widely used in NTB. In this Study, 11 years rainfall data of the Pegondang/Sakra station from 1980 to 1993 are analyzed by the method. The result of probability analysis is summarized below.

Design Rainfall

Unit : mm

Return Period	Design Rainfall
1 in 2 year	78
1 in 5 year	96
1 in 10 year	107
1 in 20 year	117
1 in 50 year	130
1 in 100 year	140
1 in 200 year	150

2) Design flood

The following is the Ruziha's formula to estimate the flood travel time:

$$T = L/V$$

$$V = 72(H/L)^{0.6}$$

where, T : Flood travel time (hr)
L : Horizontally projected length of river course (km)
H : Difference of elevation (m)
V : Velocity of flood (km/hr)

The rainfall intensity within concentration time of the flood is estimated by an empirical formula prepared by Dr. Mononobe as follows:

$$r = (R_{24}/24) \times (24/T)^{2/3}$$

where; r : Maximum average rainfall intensity within concentration time (mm/hr)
R_{24} : Daily rainfall (mm)
T : Time of concentration (hr)

The runoff coefficient is estimated at 0.8 considering the condition of the catchment area.

Based on the above condition, the peak floods in various return period are estimated. The result is shown in Table 3.3 and summarizes below.

Probable Flood

Unit : m^3/s

Return Period	Probable Flood
1 in 2 year	19
1 in 5 year	24
1 in 10 year	27
1 in 20 year	29
1 in 50 year	32
1 in 100 year	35
1 in 200 year	37

(3) Sediment load

There is no available data on sediment load on the Moyot river. The Technical Report I (Embung Study Program) in the Sumbawa Water Resources Development Planning Study Extension Phase in 1982 indicates that the sedimentation rate is 0.5 mm/year/km ^{2}. Taking data availability and characteristics of the catchment area into account, 0.4 mm/year/km^2 is adopted in this Study.

(4) Water quality

On October 24, 1994, water samplings were carried out at the proposed Embung site and upstream and downstream of the site for the clarification of the water quality. The result of the test is shown in Table 3.4.

4. EMBUNG DEVELOPMENT PLAN

4.1 Optimization of Development Scale

The water balance study aims to clarify the relationship among the proposed Embung scale, irrigable area and cropping pattern. According to the water demand and procedure to be described below, the water balance study of the Montong Krarak Embung Project is conducted.

(1) Methodology

The simulation equation is as follows:

$$W_2 = W_1 + I - L - S_P - O_D - O_L - O_I$$

where, I : inflow to reservoir at the half monthly period (m^3)
L : water losses from the reservoir caused by evaporation during the half monthly period (m^3)
S_P : flow of water over the spillway during the half monthly period (m^3)
O_D : outflow needed for domestic water during the half monthly period (m^3)
OL : outflow needed for livestock water during the half monthly period (m^3)
O_I : outflow needed for irrigation water during the half monthly period (m^3)
W_1 : volume of water in the reservoir at the beginning of the half monthly period (m^3)
W_2 : volume of water in the reservoir at the end of the half monthly period (m^3)

1) Inflow

Since there is no gauging station on the Kali Moyot river, discharge is generated from rainfall of the Pegondang/Sakra station.

2) Reservoir storage curve

Reservoir storage curve with surface area is shown in Figure 4.1 in relation to the elevation at the proposed Embung site.

3) Losses

Evaporation from inundation area can be estimated as "1.1 x ETo", indicating, "open water evaporation", which is employed in the Design Criteria KP-1.

4) Spill out discharge from reservoir

Spill out discharge is considered if there is any excess storage which exceeds the maximum storage capacity of dam.

5) Water Demand

The 100% dependability of the domestic water demand shall be secured by the proposed Montong Krarak Embung.

To meet 80% dependability of irrigation water, reservoir capacity will be determined.

6) Water level of reservoir

Minimum water level is estimated at El. 202.9 m considering sedimentation volume for 25 years and 0.5 m allowance. Maximum water level for the simulation is equal to the crest elevation of spillway. Probable maximum high water level according to topography is set at El. 205.0 m.

(2) Optimum development scale

With respect to the Montong Krarak Embung, the plan with the most sizable reservoir is selected within economically reasonable range, in view of maximum exploitation of the endowed water resource. The optimum development scale of Montong Krarak Embung is decided by the limitation of topography at the proposed Embung site. The optimum development scale is thus in line with the maximum height of 12.0 m and effective storage capacity of 0.062 MCM. The result of the reservoir operation is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

(1) Delineation of Beneficiary Irrigation Area

By developing available water resources of the Kali Moyot river through construction of the proposed Montong Krarak Embung at the optimum scale, irrigation water can be supplied to wet paddy field of 44 ha in net only for the wet season. Therefore, it is needed to delineate the beneficiary area of the proposed Embung from the existing rainfed paddy field. Taking such very limited water supply condition into account, the future cropping pattern under the "With-Project" condition is revised to the two cropping of irrigated wet season paddy and rainfed red onion and soybean as Palawija crops as shown below and illustrated in Figure 4.3.

Under the "Without-Project" condition, no new irrigation water source can be developed so that the future cropping pattern is to remain in the same condition of the present pattern on rainfed paddy field.

Future Cropping Pattern

Condition	Wet season			Dry Season		
	Crop	Water Supply	Area (ha)	Crop	Water Supply	Area (ha)
With Project	Paddy	Irrigated	44	Soybean	Rainfed	22
				Red onion	Rainfed	22
Without Project	Paddy	Rainfed	44	(Fallow)		-

(2) Delineation of beneficiary area for domestic water supply

With regard to domestic water demand in the Project area, it is better to look for other permanent water sources because water shortage problems occur during the dry season. Thus, the water source facility to be newly developed is to be utilized for supplementing irrigation water to grow the wet season paddy.

4.3 Embung Development Plan

Following the results of the geological and material surveys as well as the optimization study, the proposed development plan of Montong Krarak Embung is determined. In terms of dam type, masonry gravity type is applied in due consideration of the foundation strength and the availability of embankment materials.

The main components of Montong Krarak Embung are the main dam, spillway, river diversion conduit and water supply facility as shown in Figure 4.4. In order to provide the reservoir with the optimum storage capacity of 0.062 MCM, the full supply level (F.S.L.) is set at El. 205.0 m. Taking overflow depth of spillway and freeboard into account, the dam height of Montong Krarak Embung becomes 12.0 m above the river bed. In order to release the flood discharge during the construction period, a by-pass conduit with a shape of 1.5 m x 1.5 m square is provided in the dam body. The spillway is located on the middle portion of the main dam to release the flood discharge of 35.0 m^3 /sec from the catchment area of 5.4 km^2. For the purpose of supplying domestic water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 160 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Montong Krarak Embung are summarized below.

(1)	Reservoir	
	- Catchment area	5.4 km^2
	- F.S.L.	El. 205.0 m
	- Minimum Operating level	El. 202.9 m
	- Effective storage capacity	62,000 m^3
	- Dead storage capacity	63,000 m^3
	- Gross storage capacity	125,000 m^3
	- Sediment deposition level	El. 202.4 m
(2)	Main dam	
	- Type	Stone masonry dam(Gravity)
	- Height	12.0 m above river bed
	- Crest elevation	El. 207.0 m
	- Crest length	210 m
	- Crest width	4.0 m
	- Upstream slope	1 : 0.5
	- Downstream slope	1 : 1.0
	- Total masonry volume	12,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	35 m^3/sec
	- Type	Overflow weir
	- Crest elevation of overflow weir	El. 205.0 m
	- Width of overflow weir	35.0 m
	- Discharge capacity	35 m^3/sec
	- Overflow depth	0.6 m
(4)	River diversion	
	- Design flood (1/5 year)	24 m^3/sec
	- Type	By-pass in dam body
	- Diameter	1.5 x 1.5 m square
	- Length	15.0 m
(5)	Water supply system	
	- Inlet structure	Spindle gate with trashracks
	- Gate size	0.3 x 0.3 m square
	- Design discharge	60 lit/sec
	- Pipe diameter	160 mm

-	Outlet elevation	El. 199.0 m, Left abutment of dam site

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Main Dam

Considering the geological condition and available construction materials around the dam site, stone masonry dam is applied for constructing the Montong Krarak Embung.

1) Dam height

Resulting from the optimization study based on irrigation benefit and construction cost, the dam height is decided to be 12.0m in order to maximize the reservoir storage capacity. Actually, the dam height is limited to be El. 207.0 m as crest elevation due to topographic condition of the Embung site as seen in Figure 5.1.

2) Freeboard

The freeboard of main dam is designed taking into consideration the rise of reservoir water surface due to extraordinary flood discharge and wave uprush on the slope.

The following formula is applied for the design of the Montong Krarak Embung.

$$Hf = 0.05h + 1.0 \text{ (m)}$$

where, Hf : freeboard
h : height from river bed to the designed flood level.

(2) Saddle dam

In order to keep the crest elevation on the right abutment of the main dam, a saddle dam is designed on the saddle portion about 200m in length. Homogeneous earthfill dam is selected for the saddle dam with the maximum height of 3.0 m above the original ground.

(3) River diversion during construction

During the construction of the main dam, river flow including flood discharge should be diverted to avoid inundation of he dam site. in order that, by-pass conduit with closing gate is provided in the dam body of the Montong Krarak Embung. Dimension of the by-pass conduit is 1.5 x 1.5 m square and the formation height set at El. 195.0 m which is the same elevation of the river bed.

Before commencement of the reservoir water impounding, the by-pass conduit is closed by using closing gate plugged by the concrete with contact grouting.

(4) Spillway

The spillway is located middle portion of the main dam as overflow section as shown on Figure 4.4. The overflow weir is designed to cope with the design flood inflow with a flood surcharge space of 0.6 m (overflow depth) provided above Full Supply Level (F.S.L.) of El. 205.0 m The design flood is determined at 100 year probable flood having a peak discharge of $35m^3/sec$.

Based on comparative study on combination of overflow depth and width of the spillway, overflow depth at 0.6 m and width of 35.0 m are decided so as to minimize the cost of spillway and the main dam. A spillway bridge is provided over the overflow section in order to connect the crest road from the right to the left.

(5) Water supply system

In order to supply the water to the downstream irrigation area, the water supply system is provided to release the water of 60 lit/sec. The water supply system consists of inlet structure with trash racks, gate control house and water supply pipe with diameter of ϕ 160 mm.

Inlet formation is set at just above the sediment deposition level of El. 202.4 m and pipe outlet elevation is El. 199.0 m so as to connect the water supply pipe from the dam body to the existing irrigation canal.

5.2 Preliminary Design of Irrigation Facilities

(1) Basic concept

The following basic concepts are applied for the preliminary design of irrigation facilities in line with the development strategy:

- Irrigation area is defined taking into consideration the available cropped field and the effective storage capacity of Embung;
- The existing canal are used though full rehabilitation is required; and,
- Drainage improvement is not required for the existing cropped field since the beneficiary area is situated on well drained land.

(2) Irrigation plan

Irrigation water taken from the reservoir is led to the valve house through the cast iron pipe provided inside the dam body on the left abutment. Domestic water and the irrigation water are diverted at the valve house with check valve and flow meter.

Irrigation water diverted at the valve house is discharged to the irrigation inlet box to make the open flow from the pipe pressure flow. The irrigation inlet box is constructed at the toe of the downstream slope of the dam embankment. From the irrigation inlet box, irrigation water flows down in the existing canal. It divides into two flows at the turnout situated at about 100 m downstream from the dam site and is delivered to wet paddy field.

General layout is shown in Figure 5.1 including the layout of irrigation canals and pipe lines for domestic water supply.

(3) Design discharge and initial water level

Design discharge for canal and related structures are decided based on the irrigation water requirement and proposed cropping pattern. Peak semi-monthly base diversion requirement for the unit irrigation area of 1.0 ha is defied as a design discharge after multiplying the irrigation area. Peak diversion requirement occurs in the first half month of January for the wet season paddy and its design discharge is estimated at 60 lit/sec for the net irrigation area of 44 ha.

Initial water level at the irrigation inlet box is decided taking the elevation at the box site into consideration. As a result, the initial water level is El. 199.0 m at the irrigation inlet box.

(4) Irrigation facilities

Design of irrigation facilities is made based on the 1/5,000 topographic map prepared under the Study and in accordance with the following condition:

- The types of canal related structures are to be minimized as much as possible; and,
- The structures are to be simplified as much as possible.

Canal related structures required are irrigation inlet box and turnout to divide water from the existing upper canal to the lower canal. Required irrigation facilities are summarized below.

Irrigation Facilities Requirement

Facilities	Quantities
- Valve house (included in the facilities for Embung)	1 No.
- Irrigation inlet box	1 No.
- Turnout	1 No.
- Masonry flume type canal to be rehabilitated	2.9 km

5.3 Preliminary Design of O&M Road

No all weathered road is available in and around the Embung site. It is therefore planned to provide O&M road to the dam site aiming at smooth undertaking of O&M works after completion of the Embung. Main features are summarized below.

Main Features of O&M Road

Item	Unit	Quantities
Required length	km	0.15
Width	m	7.0
Pavement		Gravel

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding.

The construction plan is based on the mode of construction and the target schedule of construction works as well as local conditions such as availability of construction labor, material and equipment, as well as weather and topographic conditions of the construction site.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter and rock embankment works and 300 days per year for concreting works in view of the daily rainfall distribution in the Project area. For each working day, 8-hour shift is applied.

(2) Construction schedule

The overall construction schedule is determined as shown in Figure 6.1 taking into account the necessary time of detailed design, bidding procedure including the time of tender evaluation and award of the contract. The major points of construction schedule are described below.

1) Mobilization and preparation works

Immediately after received the "Notice to Proceed", the contractor would commence the mobilization of the construction equipment and key staffs to the site from beginning of November in the first year. Following the above, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of all the structures would be commenced by the contractor at the Project site. Construction of temporary access roads such as access to the borrow area and access to major structural sites shall be started by using equipment available at the Project site. The excavation works for the river diversion by-pass would be commenced at the beginning of March in the second year.

3) Excavation and masonry works

After completion of the concrete placing into the river diversion by-pass culvert, excavation works for the main dam will be commenced. Masonry works for the main dam and the spillway shall be concentrated and completed before October, in the second.

4) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at beginning of October, 2nd year after completion of the main dam and spillway construction. Considering the rainfall in November and December, 2nd year, the Montong Krarak reservoir would be full reservoir water condition, accordingly the water can be supplied from the reservoir to the water users from January in the third year.

5) Water distribution system

Construction works for the water distribution system will be executed in parallel with the construction works of the Embung by using mainly manpower because of the work quantities for them are not so much. These works shall be completed by the end of December before supplying the reservoir water to the beneficiary area.

6.2 Construction Plan of Embung

(1) Preparatory works

The preparatory works consist of preparation of temporary buildings, construction plant and repair shop, arrangement power and water supply systems as well as communication system, construction of access and haul roads, and so on. All of these works will be conducted from November in the first year to February in the second year.

1) Temporary buildings and yards

The temporary buildings required for the construction would include office, quarters, workshop, warehouse and storage yards. These temporary buildings will be built by the contractor.

2) Water and power supply

The water required for the construction works and the daily use in the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the contractor's diesel generators.

(2) River diversion works

The river flow will be released through the river diversion by-pass conduit during the dry seasons in the second year, and therefore, the river diversion conduit would be provided in the dam body.

After completion of the main dam masonry works around the end of September in the second year, the river diversion conduit shall be closed by closing gate and plugged by the concrete using concrete pump.

(3) Main dam and spillway masonry works

Following the foundation excavation and completion of the river diversion conduit, the masonry works for the main dam and spillway will be commenced at the beginning of May in the second year and completed at the end of September in the second year.

(4) Saddle dam

Excavation for the foundation of the saddle dam will be commenced in March of second year and the embankment works will be completed within the dry season of the second year as shown in Figure 6.1.

6.3 Construction Plan of Irrigation Facilities and O&M Road

Since the irrigation facilities to be constructed are rather small in work quantities and scattering in the beneficiary area in comparison with the Embung construction works, almost all the works will be basically executed by man power. These works including rehabilitation of the existing canal will be also executed in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Responsible organization for Project implementation

In the course of Project implementation, DPUP of NTB, after getting approval from DGWRD, will direct the PKSA Lombok Project Office to commence undertaking of detailed investigation and design works of the Montong Krarak Embung. These works will be done by the Survey and Investigation Section as well as the Technical Design Section of the said Project Office. Based on the cost estimate, DPUP of NTB will disburse budget for land acquisition and construction of Embung and related facilities to the Project Office using development budget allocated from the Central Government. Before starting construction work, land acquisition work will be carried out by the Land Acquisition Section of the Project Office. Supervision of construction works, being entrusted to a contractor through tendering, will be the responsibility of the Construction and Implementation Section of the Project Office.

(2) Technical resources input

In due consideration of the current availability of engineers and technical staff as well as the annual development target in the PKSA Lombok Project Office, it is necessary to utilize technical resources outside the Project Office to the maximum extent for enabling the Project Office to realize its target. In this connection, undertaking of detailed investigation and design works for the Montong Krarak Embung need to be entrusted to consultants aiming to secure smooth implementation of the Project in accordance with the implementation program made by the Project Office.

(3) Organization for O&M

After completing all of Project works for Montong Krarak Embung, DPUP of NTB will submit its completion report to the Minister for Public Works through DGWRD and therefrom the notice of Project completion will be transferred to the Minister for Home Affairs. After receiving the Minister's direction, the Governor of NTB Province will order DPUP of NTB to take a necessary action for O&M of the said Project facilities. Following this, DPUP of NTB will direct its Provincial Project O&M Office to arrange O&M works and disburse the Provincial Government's budget to DPUP Kabupaten Lombok Timur Office.

(4) Water User's Association (P3A)

In the Project area, the existing P3A has been active since 1994. It is therefore necessitated to make the new beneficiary farmers become members of this P3A and to train them by using training materials and modules prepared by the Water User Training Program under DGWRD.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for developing the Montong Krarak Embung is estimated on the basis of assumptions as follows :

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 20% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTB as of October 1994 and the data collected from the on-going projects in NTT and NTB. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of PRWS's staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to the recent other project costs in NTT and NTB;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow areas, and land of pipe line, irrigation canal and permanent structures and is estimated at 0.5 % of the direct construction cost taking into consideration the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction works will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of direct construction cost, administration cost, engineering service cost, physical contingency,

contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Montong Krarak Embung is estimated at Rp. 2,682 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works is shown in Table 7.2 together with work quantities of the main work items and unit prices.

The total Project cost for constructing the Montong Krarak Embung is summarized below.

Summary of Project Cost for Montong Krarak Embung

Unit : Rp. Million

Item		Project cost
I.	Direct construction cost	1,472
1.1	Preparatory works	70
1.2	Embung construction	1,230
1.3	Irrigation facilities	163
1.4	Domestic water supply	0
1.5	Operation & maintenance road	9
II.	Administration cost	74
III.	Engineering services	221
IV.	Physical contingencies	265
V.	Contract tax	196
VI.	Land acquisition	7
VII.	Price contingency	447
	Grand Total	2,682

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries of O&M staff, cost for maintaining the Project facilities, material and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are assumed at Rp. 13.9 million, 0.5 % of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

The inhabitants in Sakra and Rumbuk Villages intend to get a new domestic water source. The future domestic water demand for 4,584 beneficiary inhabitants is projected to be 166.7 MCM in the year of 2008. However, surface flow of their water source river, has been already withdrawn to the maximum level through the existing nine irrigation intake weirs constructed along the full stretch of the river. Due to the topographic limitation, it is also impossible to secure enough storage capacity meeting both irrigation and domestic water requirements at the proposed Montong Krarak Embung site. Therefore, the future demand for domestic water will be covered with new water resources to be developed in other river basins.

8.2 Economic Consideration

(1) Economic cost

The financial costs are to be converted into the economic costs by applying the economic conversion factor (ECF) established by DGWRD in 1985. The ECFs applied are: 0.71 for preparatory works and all civil works including Embung, irrigation facilities, domestic water supply system and road networks; 0.75 for unskilled on-farm labor and farm labor; 0.80 for land clearing, on-farm development and operation and maintenance cost; and tertiary irrigation system development, 0.90 for design and survey works and administration; and 1.00 for O&M equipment and replacement cost.

When the financial cost is converted to the economic cost, the contract tax, land acquisition cost and price contingency are fully excepted. In this Study, only the purchasing cost of consumables and goods appropriated in the administration cost is to be converted to the economic administration cost, as the normal payment to civil servants is principally appropriated in the operation budget of the Government. As the construction cost of dam and engineering cost estimated include some allowance to cover additional cost for expatriates, 50% of the engineering cost is to be converted to the economic cost in order to make the estimated cost equal to the level of local cost.

The economic cost converted and its annual disbursement schedule are shown in Table 8.1.

(2) Economic benefit

The irrigation benefits of the Project are principally derived from increased crop production attributable to stable irrigation water supply, full utilization of available farm land resources and optimum farm input supply. Table 8.2 gives financial and economic prices of farm inputs and outputs estimated for major islands. Based on the proposed quantity of farm inputs, anticipated crop yield and economic farm gate prices, the economic crop budget is estimated as shown in Table 8.3.

The annual net incremental benefit is thus estimated to be Rp. 60.4 million. This increment benefit will accure from the first year when irrigation water can be released from the Montong Krarak Embung. Taking the present agricultural situation and farmers capability into account, it is assumed that five years are needed as the build-up period to attain the anticipated crop yield level. In the proposed reservoir area, there will be no production foregone by constructing the proposed Montong Krarak Embung.

(3) Economic evaluation

The economic internal rate of return (EIRR) is examine as shown in Table 8.4 on costs and benefits as at August 1994. The result of economic analysis reveals that there is no economic merit in developing the proposed Montong Krarak Embung because the economic benefit attributed to the Embung development is too small compared with the required capital cost as the topographic condition limits to enlarge the reservoir capacity of Embung resulting in new irrigation area of only 44 ha.

(4) Farm budget analysis

With the implementation of the Montong Krarak Embung Project, the net on-farm income of farmers holding a unit farm size of 1.0 ha can be expected to increase by Rp. 2,364,830/year from Rp. 449,750/year under the "Without Project" condition with the cropping intensity of 100% to Rp. 2,814,580/year under the "With Project" condition with the cropping intensity of 200% as shown in Table 8.5 and below. Such improvement of farm budget would give much incentive for farmers to make further investment in improvement of their living standard and also could increase their payment capacity enabling beneficiary farmers to pay irrigation water charge to some extent.

Farm Budget for Unit Farm Size of 1 Ha

Crop	Watering Condition	Without Project		With Project	
		Crop Intensity (%)	Income (Rp.)	Crop Intensity (%)	Income (Rp.)
Paddy	Wet/Rainfed	100.0	449,750	-	-
	Wet/Irrigated	-	-	100.0	1,009,875
Soybean	Dry/Rainfed	-	-	50.0	448,955
Tobacco	Dry/Rainfed	-	-	50.0	1,355,750
Total		100.0	449,750	300.0	2,814,580

8.3 Environmental Impact Assessment

Environmental impact assessment for the Project is carried out in consideration of the development objectives of the Project.

(1) Environmental features of the Project area

The principal features of human and physical environment in the Montong Krarak Project area are summarized as below.

Environmental Features in the Montong Krarak Project Area

Item	Description
1. Human Environment	
Social intention	Insufficiency of reliable water sources and facilities for irrigation water and domestic use
Human use	Use of well water (shortage in the dry season)
Economic activities	Cultivation of irrigated paddy and rainfed Palawija, and livestock farming
Health and sanitation	Prevalence of waterborne intestinal diseases
2. Physical environment	
Geology/land	Volcanic products of the Quaternary
Surface/ground water	Surface water is not perennially observed
Endemic fauna and flora	None
3. Others	There exists a Hindu altar in the proposed reservoir area

(2) Environmental impact assessment

The results of environmental impact assessment reveal that inhabitants are reluctant to construct Montong Krarak Embung at the proposed site because its dam axis is selected in the place adjacent to their village area and they are afraid of change in their living circumstances and acquisition of their small patches of land.

(3) Primary information of environmental assessment

To support environmental analysis presentation for this Project implementation the Indonesian rule, primary information on environmental assessment is compiled in the Attachment to Volume 4.

8.4 Contribution to Women in Development

Since housewives in the Project area manage their family budgets, an increase of the farmer's income would encourage women in investing surplus in improvement and diversification of their income sources.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

On the basis of categorization of 157 candidate schemes for the Study, the Montong Krarak Embung scheme is selected representing a typical sample scheme of which potential beneficiary area has its irrigation water intake on the source river of the proposed Embung, simple farming system with partly irrigated area and inhabitants' demand for further use of irrigation and domestic water. The proposed Montong Krarak Embung site has physically irrigable land resources of 220 ha in net and the annual discharge of 2.3 MCM from its catchment area of 5.4 km^2.

The topographic condition at the proposed Embung site is the determining factor in the optimization of development scale. The maximum dam height of Montong Krarak Embung is thus set to be 12.0 m with the total and effective storage capacities of 0.125 and 0.062 MCM, respectively. Under such condition, however, 44 ha out of the physically irrigable land resources of 220 ha will be able to be provided with irrigation water only for the wet season. It can be expected to grow the dry season Palawija crops under the rainfed condition depending on available soil moisture during the early dry season. The future domestic water demand of 0.167 MCM for 4,584 inhabitants will be unable to be covered as the priority of water supply is given to the irrigated farming.

The structural components are main dam and irrigation water distribution system. The stone masonry dam is constructed with the crest length of 210 m, masonry volume of 12,000 m^3 and overflow weir of 35 m in width and 35 m^3/sec in design flood discharge. The required investment cost amounts to Rp. 2.8 billion of which direct construction cost is estimated to be 1.5 billion.

The results of feasibility study reveal that construction of the candidate Embung at the proposed site is technically unsound and economically impossible. Though the small reservoir capacity is the main reason, overuse of the river flow by the existing nine irrigation schemes also reduce the newly usable portion of effective storage water in the proposed Montong Krarak reservoir. As inhabitants living nearby the proposed site have negative intention to construct the Montong Krarak Embung, the increasing domestic water demand of inhabitants in the Project area could be met by developing new water resources in and around the Project area. Therefore, such type of Embung is worthless implementing from the technical and socio-economic viewpoints.

9.2 Recommendations

To meet the future water demand in the Montong Krarak area, it is recommended to develop Perako Embung candidate scheme on the most upstream of Moyot river instead of the development of Montong Krarak Embung taken into account better topographic condition of the potential site and no housing areas in the potential reservoir.

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Montong Krarak Embung Development Project

Tables

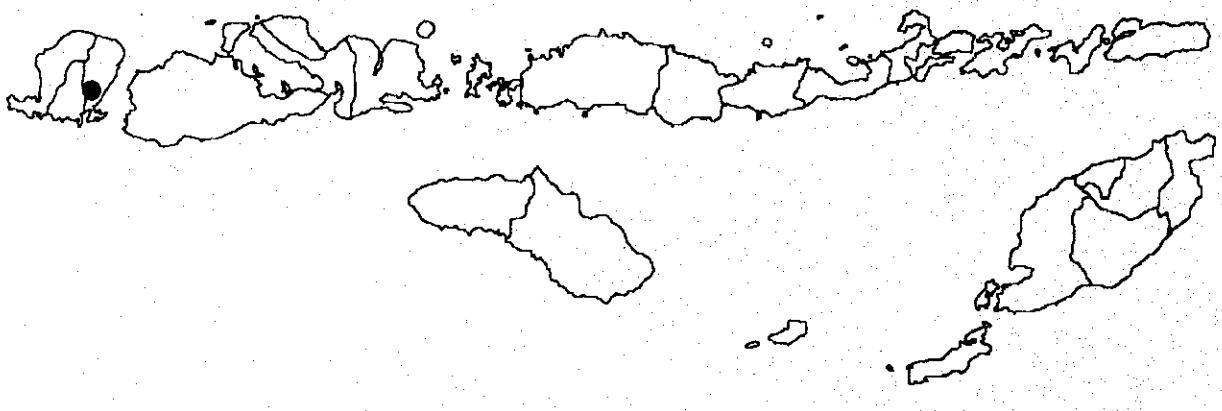

Table 1.1 Rainfall Record in Pegondang Sakra

PEGONDANG SAKRA L22

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1950		99	60	71	46	184	28	81	92	354	511	317	
1951	477	421	143	14	0	80	0	45	26	0	32	104	1342
1952	306	92	87	27	10	0	0	0	0	22	222	185	951
1953	277	174	102	69	76	0	64	0	0	5	19	150	936
1954	156	78	136	60	30	17	0	67	33	101	65	318	1061
1955	129	109	53	36	95	129	100	22	13	66	216	340	1308
1956	271	192	0	0	30	53					141	285	
1957	373	184	202	0	0	0	64	6	0	0	79	287	1195
1958	113	291	235	46	12	30	41	0	0	23	118	118	1027
1959	265	150	209	16	70	5	0	0	0	0	6		
1960	262	190	60	62	145	0	0	0	0	0	111	121	951
1961	211	159	125	36	0	0	0	0	0	0	123	136	790
1962	148	487	74	87	0	0	118	3	0	75	75	618	1685
1963	168	49	84	5	0	0	0	0	0	0	17	88	411
1964	314	273	293	0	231	25	0	0	0	234	390	159	1919
1965	200	76	107	0	0	0	0	0	0	49	190	239	861
1966	371	197	176	8	0	0	0	0	0	25	75	253	1105
1967	376	149	151	21	10	0	0	0	30	4	60	358	1159
1968	379	218	12	133	131	15	163	0	0	22	35	152	1260
1969	706	310	12	2	4	0	0	8	0	0	0	206	1248
1970	435	150	142	178	163	45	0	0	31	10	168	248	1570
1971	485	442	98	66	76	0	0	0	13	53	162	306	1701
1972	143	73	173	0	26	0	0	0	0	0	30	146	591
1973	325	422	172	115	204	44	7	21	66	0	151	142	1669
1974	156	258	182	60	2	0	0	26	17	194	233	147	1275
1975	239	239	266	154	71	0	61	0	86	347	378	261	2102
1976	191	256	142	0	25	0	0	0	0	28	0	91	733
1977	210	437	144	34	5	7	0	1	23	8	15	68	952
1978	351	185	233	28	66	365	147	52	39	113	230	231	2040
1979	108	172	76	5	128	86	0	0	0	0	154	192	921
1980	215	107	16	93	2	0	0	0	0	0	131	309	873
1981	191	124	94	19	0	54	16	16	36	41	328	270	1189
1982	246	175	244	15	0	0	0	0	0	0	14	250	944
1983	53	205	211	159	0	0	0	0	0	0	223	106	957
1984	293	177	343	93	82	6	2	16	78	85	66	216	1457
1985	194	262	373	3	14	97	108	0	0	2	341	301	1695
Max.	706	487	373	178	231	365	163	81	92	354	511	618	2102
Mean	267	211	145	48	49	35	26	10	17	53	142	221	1208
Min.	53	49	0	0	0	0	0	0	0	0	0	68	411

Sum of monthly means = 1222

Table 1.2 Climate in Selong

Station: Selong
Island : Lombok
Kabupaten : Lombok Timur

Latitude : 08 40 S
Longitude : 116 33 E
Elevation : 148 m

Description	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average	Year
Average daily maximum temperature	C	33.3	33.4	33.4	33.6	31.9	32.5	32.0	32.8	32.6	32.6	33.3	33.4	32.9	1976 - 1979
Average daily minimum temperature	C	23.8	23.4	23.2	22.9	22.4	21.6	20.4	20.9	21.9	22.9	239.0	23.2	22.5	1976 - 1979
Mean daily temperature	C	28.6	28.4	28.3	28.3	27.2	27.1	26.2	26.9	27.3	27.8	28.6	28.3	27.7	1976 - 1979
Mean daily relative humidity	%	82.0	83.0	82.0	80.0	80.0	81.0	78.0	81.0	78.0	79.0	77.0	82.0	80.0	1976 - 1979
Mean daily wind run over 24 hours	km/day	122.0	91.0	60.0	53.0	63.0	79.0	97.0	98.0	106.0	120.0	94.0	96.0	90.0	1976 - 1979
Wind speed at time of observation	m/s	1.4	1.1	0.7	0.6	0.7	0.9	1.1	1.1	1.2	1.4	1.1	1.1	1.0	1976 - 1979
Mean daily observed bright sunshine	hr/month	124.0	167.0	220.0	234.0	251.0	258.0	273.0	298.0	279.0	279.0	222.0	183.0	2.828.0	1976 - 1979
Mean daily observed bright sunshine	hr/day	5.3	5.9	7.1	7.8	8.1	8.6	8.8	9.6	9.3	9.0	7.4	5.9	7.7	1976 - 1979
Mean daily maximum possible sunshine	hr/day	12.5	12.4	12.2	12.0	11.8	11.7	11.8	11.9	12.0	12.2	12.5	12.6	12.1	1976 - 1979
Mean Solar Radiation	mm/day	16.2	16.2	15.8	14.5	13.2	12.5	12.8	13.8	15.0	16.0	16.1	16.3	14.9	1976 - 1979

Source : Repprot (Nusatenggara, Maluku, Timor Timur) Annex 3

Table 1. 3 Typical Soil Profile in the Montong Krarak Project Area

Profile No.:	2
Soil Classification:	Oxyaquic Ustropepts
Physiography:	Mountain foot slope
Topography:	Undulating (5 %)
Land Use/Vegetation:	Irrigated paddy field
Parent material:	Mixed, sandy-basaltic material
Drainage:	Moderately well
Groundwater Table:	8 - 10 m
Permeability:	Slightly slow (1.57 cm/hr)
Land Morphology:	

Horizon	Depth (cm)	Description
Ap	0 - 18 cm	Brown (10YR 5/2, dry); clay; 5 % coarse material, 3 - 5 mm; strong, angular blocky, medium structure; slightly sticky, slightly plastic, firm, hard consistency; common, medium root; clear, smooth horizon boundary
Bw	18 - 39 cm	Brown-dark brown (7.5YR 4/4, moist); sandy clay loam; pumice-coarse material; moderate, angular, blocky, medium structure; slightly sticky, slightly plastic, firm consistency; clear, wavy horizon boundary
BC	39 - 50 cm	Brown-dark brown (7.5YR 4/4, moist); sandy loam; weak, granular, fine structure; non sticky, non plastic, friable consistency; gradual, wavy horizon boundary
C	50 - 100+	Brown-dark brown (7.5YR 4/4, moist); sandy loam; 30 % pumice-coarse material; moderate, granular, coarse structure; non sticky, non plastic, friable consistency

Source: Soil survey carried out by the local consultant under supervision of the JICA Study Team

Table 1.4 Results of Soil Laboratory Test in the Montong Krarak Project Area

Soil Pit	Layer	Texture			Permeability	pH	pH	Organic	Total N	Ava. P	CEC	Ex. Na	Ex. Ca	Ex. K	Ex. Mg	Base	EC
		Sand (%)	Silt (%)	Clay (%)	(cm/hr)	(H2O)	(KCl)	matter	(%)	(ppm)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	Saturation (%)	(mS/cm)
2	Ap	38.5	27.2	34.3	1.6	6.3	5.4	2.18	0.05	4.56	28.91	0.97	10.20	1.70	3.85	58	0.52
	Bw	35.4	29.6	35.0	2.0	6.7	5.6	0.70	0.06	2.20	20.11	0.94	8.09	1.53	2.37	64	0.20
	BC	73.4	15.6	11.0		7.1	6.0	0.30	0.06	2.07	13.32	0.90	5.75	1.11	1.96	73	0.06
5	Ap	70.0	7.0	23.0	0.3	7.2	5.5	1.21	0.06	4.08	26.35	1.09	10.74	1.97	2.83	63	0.12
	Bw1	40.2	26.3	33.5	1.5	7.2	6.0	0.59	0.04	2.31	30.83	1.15	10.29	1.02	3.27	51	0.12
	Bw2	58.6	16.3	35.0		6.9	5.7	0.31	0.03	1.89	35.37	1.56	10.73	2.44	4.18	53	0.26
6	Ap	60.4	15.3	24.3	2.3	7.3	6.2	0.81	0.05	6.96	22.34	1.15	10.83	1.23	2.67	71	0.20
	2A	56.6	10.3	33.0	1.1	7.0	5.8	0.53	0.04	3.42	38.12	2.16	10.87	2.00	3.47	49	0.16
	3A	56.4	6.6	37.0		7.1	6.3	0.38	0.04	2.10	44.36	2.94	10.91	1.95	4.89	47	0.60

Source: Soil survey carried out by the local contractor under supervision of the JICA Team

Table 1.5 Soil Classification in the Montong Krarak Project Area

Land Unit	Description	Physiography	Topography	Potential Suitability			Area	
				Paddy	Soybean	Maize	(ha)	(%)
I	Chromic Haplusterts deep; very fine clayey; neutral; high CEC; moderate permeability; well drainage	Mountain middle slope	Rolling (10-12%)	S2	S1	S1	18	6%
II	Oxyaquic Ustropepts deep; fine clay; neutral; high CEC; slightly slow permeability; well drainage	Mountain	Undulating (4-5%)	S2	S1	S1	23	8%
III	Leptic Endoauerts moderately deep; fine clayey; neutral; high CEC; moderate permeability; well drainage	Alluvial fan	Flat (0-2%)	S2	S1	S1	14	5%
IV	Typic Haplusterts deep; very fine clayey; neutral; high CEC; slightly slow permeability; moderately well drainage	Alluvial fan	Flat (1-2%)	S1	S1	S2	25	9%
V	Chromic Haplusterts deep; very fine clayey; neutral-slightly alkaline; moderate-slow permeability; moderately well drainage	Slope-alluvial fan	Undulating-flat (0-8%)	S1/S2	S1	S1	27	9%
VI	Oxyaquic Ustropepts deep; fine loamy; neutral; moderate CEC; moderate permeability; moderately well drainage	Alluvial fan	Flat (0-2%)	S1	S1	S1	47	16%
VII	Chromic Haplusterts deep; very fine clayey; neutral-slightly alkaline; high CEC; moderate-very slow permeability; well drainage	Alluvial fan	Undulating (2-4%)	S1	S1	S1	42	15%
#	Unclassified						90	31%
	Total						286	100%

Source: Soil survey carried out by the local consultant under supervision of the JICA Team

Table 1.6 Summary of Farm Household Economic Survey in the Montong Krarak Project Area

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Respond't No. 11	Respond't No. 12	Respond't No. 13	Respond't No. 14	Respond't No. 15	Average
1	Sex and Age		Male 68	Male 45	Male 30	Male 40	Male 50	Male 62	Male 60	Male 42	Male 45	Male 52	Male 55	Male 50	Male 45	Male 50	Male 50	Male 50
2	No. of Family Member		M-0/F-2	M-3/F-3	M-4/F-1	M-2/F-3	M-1/F-4	M-0/F-2	M-3/F-3	M-3/F-3	M-2/F-1	M-2/F-3	M-2/F-4	M-4/F-2	M-3/F-2	M-3/F-2	M-2/F-5	M-2/F-3
3	Type of Side Job		None	Desa Ser.	Worker	Worker	Entrepren.	None	None	Worker	None	None	None	None	None	None	HC Driver	
4	Own Farmland	ha	0.35	0.12	0.27	0.09	0.20	0.42	6.50	0.35	0.29	0.30	1.00	1.00	0.31	0.70	0.75	0.84
	Rented Farmland	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Yield Division	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	(Paddy field)	ha	0.35	0.10	0.25	0.09	0.20	0.40	5.00	0.35	0.29	0.30	1.00	1.00	0.31	0.70	0.75	0.74
5	Cropped Area	ha	1.05	0.20	0.75	0.18	0.80	0.80	9.00	0.70	0.68	0.60	2.00	1.40	0.93	1.70	1.50	1.49
	(Paddy)	ha	0.35	0.10	0.50	0.09	0.20	0.40	4.00	0.35	0.58	0.30	1.00	0.70	0.31	0.70	0.75	0.69
	(Palawija)	ha	0.70	0.10	0.25	0.09	0.60	0.40	5.00	0.35	0.10	0.30	1.00	0.70	0.62	1.00	0.75	0.80
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cow/Buffalo	head	0	0	2	0	0	1	0	0	0	0	0	1	0	0	0	0
	Horse	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Goat/Sheep	head	1	0	0	0	0	0	0	0	1	0	0	0	0	0	10	1
	Pig	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chicken/Duck	head	0	0	7	6	0	0	22	6	0	0	17	0	0	5	0	4
7	Gross Income	Rp.'000/yr	694.4	710.0	1,120.0	708.8	1,757.0	1,337.5	10,940.0	1,580.0	645.0	1,000.0	2,350.0	3,200.0	2,010.0	3,760.0	3,300.0	2,340.8
	(Crop)	Rp.'000/yr	694.4	470.0	820.0	583.8	1,277.0	1,337.5	10,940.0	780.0	645.0	1,000.0	2,350.0	3,200.0	2,010.0	3,760.0	2,850.0	2,181.2
	(Livestock)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(Side job)	Rp.'000/yr	0.0	240.0	300.0	125.0	480.0	0.0	0.0	800.0	0.0	0.0	0.0	0.0	0.0	0.0	450.0	159.7
	(Miscellaneous)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Expenditure	Rp.'000/yr	1,061.8	2,489.5	2,260.8	3,748.5	3,008.7	2,245.6	7,908.4	2,335.2	1,035.8	3,284.5	5,230.5	3,471.9	3,587.5	3,273.2	4,362.0	3,286.9
	(Food/drink)	Rp.'000/yr	693.0	1,403.4	1,489.2	2,767.2	1,794.0	1,113.6	2,695.2	1,747.2	576.0	1,338.0	2,358.0	1,142.4	1,896.0	1,075.2	2,160.0	1,616.6
	(Living)	Rp.'000/yr	148.5	515.5	258.0	256.0	788.0	412.0	1,097.0	171.0	185.0	927.2	450.0	400.0	996.0	238.0	176.0	467.9
	(Education)	Rp.'000/yr	60.0	360.0	72.0	396.0	180.0	120.0	720.0	180.0	0.0	250.0	720.0	512.0	84.0	840.0	313.0	320.5
	(Production)	Rp.'000/yr	160.3	210.6	441.6	329.3	246.7	600.0	3,396.2	237.0	274.8	769.3	1,702.5	1,417.5	611.5	1,120.0	1,713.0	882.0
9	Surplus/Deficit	Rp.'000/yr	-367.4	-1,779.5	-1,140.8	-3,039.7	-1,251.7	-908.1	3,031.6	-755.2	-390.8	-2,284.5	-2,880.5	-271.9	-1,577.5	486.8	-1,062.0	-946.1
10	Saving	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	1,500.0	0.0	200.0	0.0	0.0	0.0	0.0	240.0	0.0	129.3

Source : JICA Agro-economy Survey

Table 2.1 Estimated Evapotranspiration in Montong Krarak Project

Site : Montong Krarak
Meteorological Station : Selong

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	C	28.60	28.40	28.30	28.30	27.20	27.10	26.20	26.90	27.30	27.80	28.60	28.30
RH mean	%	82.00	83.00	82.00	80.00	80.00	81.00	78.00	81.00	78.00	79.00	77.00	82.00
U km/day	km/day	122.00	91.00	60.00	53.00	63.00	79.00	97.00	98.00	106.00	120.00	94.00	96.00
ea	mbar	38.95	38.49	38.26	38.26	35.91	35.70	33.81	35.28	36.12	37.17	38.95	38.26
RH/100		0.82	0.83	0.82	0.80	0.80	0.81	0.78	0.81	0.78	0.79	0.77	0.82
ed	mbar	31.94	31.95	31.37	30.61	28.73	28.92	26.37	28.58	28.17	29.36	29.99	31.37
(ea-ed)	mbar	7.01	6.54	6.89	7.65	7.18	6.78	7.44	6.70	7.95	7.81	8.96	6.89
f(u)		0.60	0.52	0.43	0.41	0.44	0.48	0.53	0.53	0.56	0.59	0.52	0.53
(1-W)		0.23	0.23	0.23	0.23	0.24	0.24	0.25	0.24	0.24	0.23	0.23	0.23
(1-W)f(u)(ea-ed)	mm/day	0.96	0.77	0.68	0.72	0.76	0.79	0.99	0.87	1.05	1.08	1.07	0.83
Ra	mm/day	16.40	16.30	15.50	14.20	12.80	12.00	12.40	13.50	14.80	15.90	16.20	16.20
n	hr/day	5.30	5.90	7.10	7.80	8.10	8.60	8.80	9.60	9.30	9.00	7.40	5.90
N	hr/day	12.60	12.40	12.10	11.80	11.60	11.50	11.60	11.80	12.00	12.30	12.60	12.70
(0.25+0.50n/N)		0.46	0.49	0.54	0.58	0.60	0.62	0.63	0.66	0.64	0.62	0.54	0.48
Rs	mm/day	7.55	7.95	8.42	8.24	7.67	7.49	7.80	8.87	9.44	9.79	8.81	7.81
Rns	mm/day	6.04	6.36	6.74	6.59	6.14	5.99	6.24	7.09	7.55	7.83	7.05	6.25
f(T)		16.42	16.38	16.34	16.34	16.14	16.10	15.94	16.06	16.14	16.26	16.42	16.34
f(ed)		0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.10	0.10	0.10	0.09	0.09
f(n/N)		0.48	0.53	0.63	0.69	0.73	0.77	0.78	0.83	0.80	0.76	0.63	0.52
Rnl=f(T)f(ed)f(n/N)	mm/day	0.68	0.75	0.91	1.05	1.17	1.23	1.37	1.34	1.32	1.20	0.98	0.75
Rn =Rns-Rnl		5.36	5.61	5.82	5.55	4.96	4.76	4.87	5.75	6.23	6.63	6.07	5.50
W		0.77	0.77	0.77	0.77	0.76	0.76	0.75	0.76	0.76	0.77	0.77	0.77
W Rn		4.14	4.33	4.49	4.28	3.78	3.61	3.66	4.36	4.75	5.09	4.69	4.24
c		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Eto	mm/day	5.60	5.61	5.69	5.50	4.98	4.84	5.11	5.75	6.38	6.79	6.33	5.58

Source : JICA Study Team estimation by Modified Penman Method based on the meteorological data at the Selong statin